# CONTROL DATA®

## MODEL 3290-D DISPLAY EQUIPMENT

- General Description
- Operation
- Programming

# MODEL 3290-D DISPLAY EQUIPMENT HARDWARE REFERENCE MANUAL

## SECTIONS IN THIS MANUAL:

Section I — General Description

Section II — Operation

Section III — Programming

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## Model 3290-D Display Equipment HARDWARE REFERENCE MANUAL Revised Edition

DESCRIPTION		
Released		
Revised - to incorporate Option 10033-C (80 by 13 display		
format) which is used in the Display Controller. Affected pages		
are: cover, title, copyright, A, i, 1-1, 1-3, 1-4, 3-14, 3-30,		
3-31, 3-32, 3-33.		
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#### **FOREWORD**

This manual contains information to guide personnel in operating the CON-TROL DATA Model 3290-D Display Equipment. This manual explains the operation of the display equipment from a user's point of view and bridges the gap between the more detailed customer engineering publications for each device.

Discussion in this manual is arranged in three basic sections. A brief outline of each section follows:

Section I, General Description — contains functional, operational, physical descriptions, and electrical data.

Section II, Operation — lists controls and their functions and explains operating procedures through use of the controls.

Section III, Programming — gives programming aspects of the display equipment. Information is provided on function codes, status codes, interface signals, word formats, etc.

For a more detailed description of the equipment described herein, reference the Model 211–G, H, J, K, L, P Display Station Reference/Customer Engineering Manual (publication number 82117800), Model 218–F, G Printer Station Reference/Customer Engineering Manual (publication number 82132900), and Model 3290–D (with 215–B Poller and including Option 10033–C) Customer Engineering Manual, Books 1 through 4 (publication numbers 82123000, 82123100, 82135600, 82123200, and 82123300, respectively).

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Figure 1-1. Typical Set of Display Equipment

#### SECTION I

## GENERAL DESCRIPTION

The display equipment, designed for use with a CONTROL DATA 3000 Series computer, consists of a Display Controller and a combination (not to exceed 12) of Display Stations, Printer Stations, and pollers.

A typical set of display equipment is shown in figure 1-1. The display equipment provides access to data storage and computational capabilities of a central computer complex by means of inquiry and retrieval Display Stations. To obtain hardcopy records of displayed messages, transfer data to an associated off-line Printer Station. The poller allows communications between the computer and remote sites.

The Display Stations and/or Printer Stations may be located as far as 1000 feet from the Display Controller. A Display Station and its associated logic circuitry must be employed for every Printer Station used; however, one Printer Station may serve more than one Display Station. The poller assembly controls communications between the 3000 Series computer and a remote terminal Display Controller. Communications between the poller assembly and the remote Display Controller take place over conventional phone lines utilizing a DATA-PHONE\* Data Set 201A or 201B.

## OPERATIONAL DESCRIPTION.

Data is entered on the Display Station 14-inch (diagonal measurement) cathode ray tube (crt) screen from the computer at an approximate rate of 50,000 symbols per second and from the Display Station keyboard at operator typing speeds. Standard display format is 20 lines of 50 symbols per line within a nominal 8-inchwide by 6-inch-high raster area. An optional display format is available with 13 lines of 80 symbols per line.

Symbol intensity is adjustable and the P4 phosphor-coated crt makes displays clearly legible in normal office lighting. Data presented on the display screen is refreshed at a flicker-free rate of 50 cycles per second. Symbol dimensions are nominally 1/8-inch wide by 1/4-inch high.

<sup>\*</sup> Trademark of AT&T

An entry marker, displayed as an underline, conveniently indicates to the operator where the next symbol will appear. The entry marker can be positioned anywhere within the 8 by 6 inch viewing area and moves automatically across the page as each symbol is typed, or inserted by the computer. At the end of a line, the entry marker automatically moves to the first symbol position in the next line down. When it reaches the end of the last line on the page, it automatically moves to the first symbol position in the upper left corner of the screen.

Positioning the entry marker at the end of the print message and depressing the keyboard PRINT key transmits displayed messages to an associated Printer Station. Data from the top of the screen to the entry marker position is transmitted to the Printer Station and typed out at the rate of 15.5 symbols per second on continuous strip paper 9-7/8 inches wide and perforated for folding and tearing at 11-inch intervals.

## FUNCTIONAL DESCRIPTION.

The remainder of Section I describes in more detail primary Display Controller, Display Station, and Printer Station functions.

The Display Controller consists of an interface, central control and symbol generator assembly, station driver assemblies, printer driver assemblies, and may contain up to two poller assemblies. On diagrams and some figures the central control and symbol generator assembly is referred to as CBU, station drivers as SDU's and printer drivers as PCU's.

The interface enables Display Controller communications with a 3000 Series computer. Two cables (up to 200 feet long), identified as "A" and "B", provide the data link between the computer and Display Controller. Twisted-pair signal lines, contained in cables A and B, are described under interface signals in Section III.

Symbol generation, timing, and data flow gating logic are contained in the central control and symbol generator assembly. Video pulse trains, representing symbols, are developed in the symbol generator. These pulse trains are made available to each station driver. The station driver selects the proper pulse train and transmits it to the crt where it is displayed by unblanking the beam in a 5 by 7 dot matrix. Symbol dimensions are, nominally, 1/8-inch wide by 1/4-inch high. Each station driver contains logic circuitry controlling the operation of a Display Station. It receives data from the Display Station keyboard and the central control symbol generator assembly. All data sent to the station driver is stored in an associated

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10-millisecond magnetostrictive delay-line memory. All stored data is assembled and decoded in each station driver, fed to the Display Station, and displayed on the crt. The display remains visible as long as stored data is continually refreshed on the crt. Figure 1-2 is a functional diagram of the Display Station.

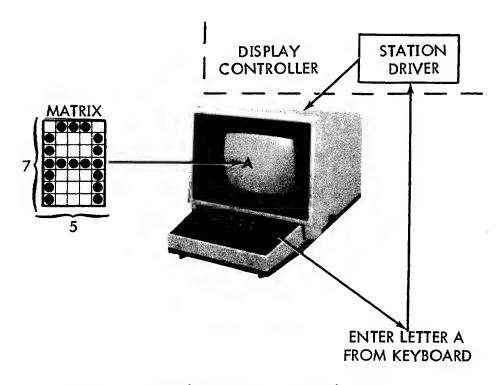


Figure 1-2. Display Station Functional Diagram

One symbol requires 16.8 microseconds to display while one line is displayed in 991.2 microseconds. Twenty lines of 50 symbols, therefore, require 19.824 milliseconds allowing 9 symbol times for horizontal retrace. Thirteen lines of 80 symbols require 19.437 milliseconds.

A printer driver contains the Printer Station control logic. Data from the station driver assembly register is translated and sent to the printer driver. Printer control and priority control logic are in the printer driver. One Printer Station can serve as an output device for up to 10 Display Stations if one poller is used or it can be used for an output device for up to 9 Display Stations if two pollers are used.

Each Printer Station contains a Selectric \* typewriter; depressing the PRINT key at a Display Station activates the typewriter. If the PRINT keys at several Display Stations associated with a Printer Station are depressed while the Printer Station is busy printing, the requests are processed in order of lowest Display Station number. Type set is designated "Data No. 1" \*\* and type spacing is 10 symbols per inch in a line with 6 lines per inch. The printer uses a black fabric ribbon to type symbols on a 9-7/8-inch-wide continuous strip paper. The paper is perforated for folding and tearing at 11-inch intervals. Feed holes are 9-3/8 inches apart and spaced 1/2 inch in the longitudinal direction.

Printout is accomplished at the following speeds: print one symbol, 64.5 milliseconds; carriage return, 129.0 milliseconds; shift, 64.5 milliseconds; and space, 64.5 milliseconds.

The Display Controller may contain a maximum of two pollers. Data is sent to or from the remote stations via the poller in 8-bit serial codes. The Data Set synchronizes all received or transmitted data. A poller controls the remote site's requests to transfer data by periodically polling (scanning) them in sequential order.

## ENVIRONMENTAL CONDITIONS.

The Display Controller operates at normal room temperature but has a blower assembly housing located beneath the logic chassis assemblies for specific cooling of the logic chassis. The Display Stations and Printer Stations also operate at normal room temperature but are cooled by radiation and convection. Tables 1–1 through 1–3 list specific environmental limitations for all three units.

## PHYSICAL DATA.

The display equipment configuration may consist of no more than 12 Display Stations, Printer Stations, and pollers. No more than two pollers may be employed, so the maximum display equipment configuration that would be possible locally would be a combination of ten Display Stations and/or Printer Stations with two pollers. The pollers are capable of communicating with up to 16 remote Display Controllers. Refer to figure 1-3.

<sup>\*</sup> IBM Trademark.

<sup>\*\*</sup> IBM Classification.

TABLE 1-1. DISPLAY CONTROLLER ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)
Temperature	+65 F to +85 F	- 30 F to +150 F
Relative Humidity	10 to 90%	0 to 100% (Note 2)
Altitude	– 1000 to + 10,000 feet	- 1000 to + 15,000 feet
Note 1 — packed for shipment.  Note 2 — includes condensation in the form of moisture or frost.		

TABLE 1-2. DISPLAY STATION ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)		
Temperature	+65 F to +100 F	-65 F to +160 F		
Relative Humidity	40 to 60%	10 to 90% (Note 2)		
Altitude	8,000 feet	12,000 feet		
Note 1 — packed for shipment.				
Note 2 — includes condensation in the form of moisture or frost.				

TABLE 1-3. PRINTER STATION ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL Normal/Standby	NONOPERATIONAL Storage/Transit (Note 1)		
Temperature	+60 F to +100 F	-30 F to +150 F		
Relative Humidity	10 to 90%	5 to 100% (Note 2)		
Altitude	- 1000 to +10,000 feet	- 1000 to +15,000 feet		
Note 1 — packed for shipment.				
Note 2 — includes condensation in the form of moisture or frost.				

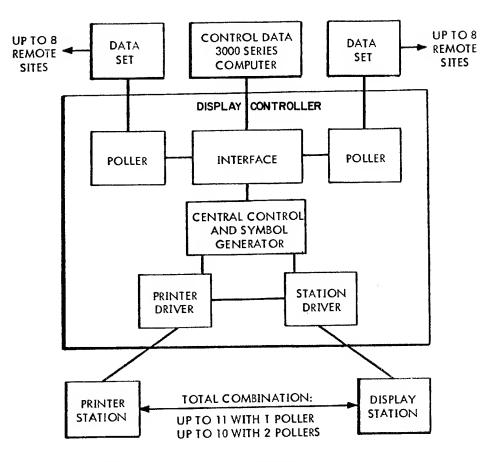


Figure 1-3. Display Equipment Block Diagram

Physical construction of the display equipment incorporates latest recognized factors in engineering, convenience, and safety to operating personnel. Figures 1-4 through 1-6 show the dimensions and approximate weight of the Display Controller, Display Station, and Printer Station respectively.

## DISPLAY CONTROLLER ELECTRICAL DATA.

The Display Controller requires 57 to 63 Hz, 187 to 216 volts, 3-phase alternating current of 8 amperes. Each station driver or printer driver requires 0.4 ampere in addition to that required for the Display Controller.

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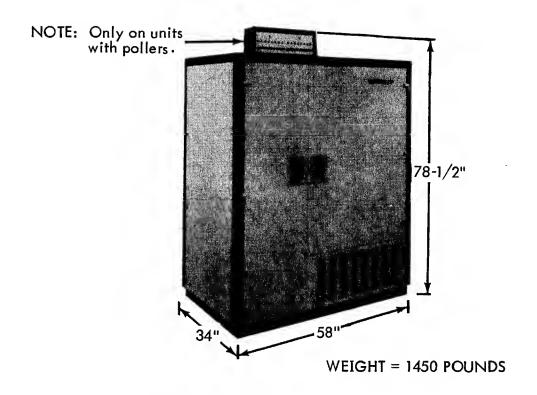


Figure 1-4. Display Controller Physical Data

## DISPLAY STATION ELECTRICAL DATA.

The Display Station requires 115/230-volt, 50/60-Hz, 3-wire, single-phase power. Power expended is 130 watts with heat dissipation of 465 Btu per hour. Voltage potentials in the Display Station range from - 16 volts dc to 10 kilovolts.

## PRINTER STATION ELECTRICAL DATA.

The Printer Station requires 120-volt, single-phase, 60-Hz power. It has a maximum current rating of 1.0 ampere, dissipates 400 Btu per hour, and is cooled by radiation and convection.

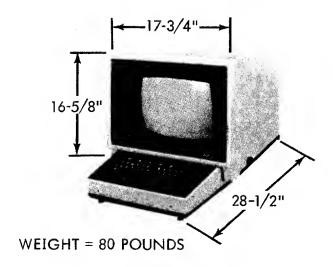


Figure 1-5. Display Station Physical Data

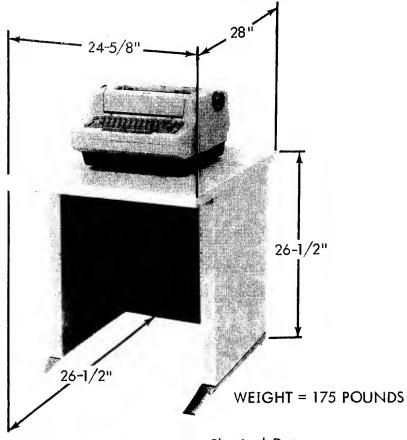


Figure 1-6. Printer Station Physical Data

## CONVENIENCE OUTLETS.

To facilitate the use of test equipment during periods of maintenance, Control Data requires that a convenience outlet be available within 15 feet of each system component cabinet. The outlets may be located in the walls or raised floor panels and must not be obstructed by storage racks or other furniture. The receptacles shall be of the single-phase grounded type, installed according to local electrical codes. For 60-hertz installations, the nominal voltage shall be 120 volts. For 50-hertz installations, the nominal voltage shall be 220, 230, or 240 volts, as dictated by the single-phase power available at the site.

#### SECTION II

#### OPERATION

This section contains a list of controls for operation and maintenance of the display equipment and also contains information on data inquiry, and turn on/turn off procedures.

## CONTROLS.

Display Equipment controls are divided into three groups: Display Controller, Display Station, and Printer Station. Following paragraphs explain control usage within each group.

The Display Controller maintenance panel controls apply power and enable checking the display equipment operational sequence. Display Station controls apply power and adjust crt intensity. The Display Station keyboard enters data into the display equipment and controls its destination. Printer Station controls apply power to the hardcopy printer.

## DISPLAY CONTROLLER.

Figure 2-1 shows the Display Controller maintenance panel. Table 2-1 explains the callouts.

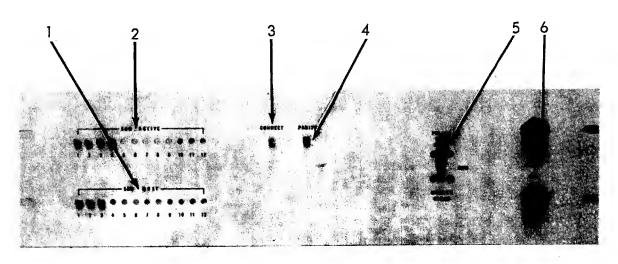


Figure 2-1. Display Controller Maintenance Panel

TABLE 2-1. MAINTENANCE PANEL CONTROLS AND INDICATORS

	¥	·	
CALLOUT	CONTROL NAME	CONTROL TYPE	FUNCTION
1	SDU BUSY 1 through 12	Indicators white	Indicates the print busy status of each Display Station.
2	SDU ACTIVE 1 through 12	Indicators white	Indicates the input/output status of each Display Station.
3	CONNECT	Indicator white	Indicates the Display Controller is connected to the computer by a computer connect code.
4	PARITY	Indicator red	Indicates the Display Con- troller has detected a transmission parity error.
5	POLLER TEST/ RUN/MASTER CLEAR	Lever switch 3-position	POLLER TEST — allows communications between remote site and poller.  RUN — enables normal Display Controller operation. MASTER CLEAR — clears Display Controller logic and all data from the delay-line memory within each station driver.
6	POWER ON/OFF	Two push— buttons	Turns Display Controller cabinet power on and off.

The auxiliary maintenance panel (figure 2-2) contains a toggle switch and a light for each of the sixteen possible remote sites (8 for each poller). The corresponding site address for each switch is labeled directly below the switch. If a switch is in the down position, the corresponding remote site receives a poll message from the poller. If it is in the up position, its site address is not polled in the poller sequence.

The indicator for each site, located directly above the switch, illuminates when a poll message is initiated to its corresponding remote site. The indicator extinguishes when the poller receives an errorless message from that site. If a particular indicator remains illuminated indefinitely, there is a communications

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problem between that site and the poller. The switch corresponding to this indicator should then be placed in the up position. This will extinguish the light and remove the site from the system.

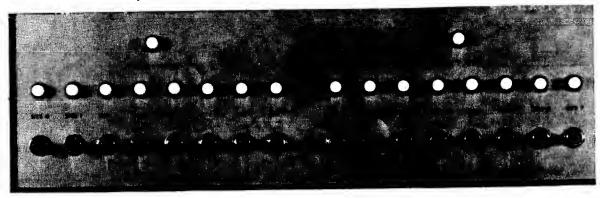


Figure 2-2. Auxiliary Maintenance Panel

Circuit breaker CB1 on the a-c control panel (figure 2-3) applies primary 208-volt, 3-phase power to the Display Controller. Also on this panel are two 120-volt ac convenience outlets and a meter, M1, which indicates the total number of hours power has been applied to the Display Controller. The six fuses located on the panel provide circuit protection for the power supplies, blower assembly, and convenience outlets.

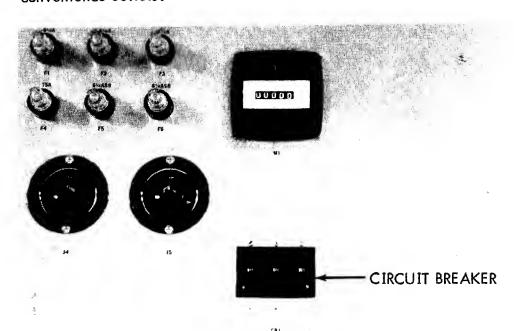


Figure 2-3. A-C Control Panel

The interface panel contains the EQUIPMENT SELECTOR rotary switch (figure 2-4) for selecting a specific external equipment address 0 through 7 for the Display Controller. The switch setting also determines which interrupt line to the computer is used. Four receptacles are provided for connecting the Display Controller to the computer; only two are used at one time. The other two should be terminated if not in use.

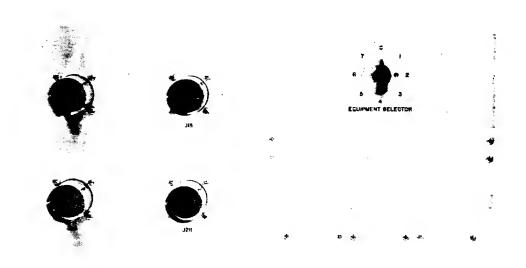


Figure 2-4. Display Controller Interface Panel

Figure 2-5 shows the Data Set interface panel. This panel provides the power and data outlets for two pollers. J1 and J2 are the data cable receptables while J3 and J4 provide 120-volt ac, 60 Hz power to the Data Set.

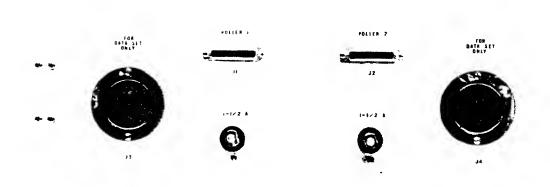


Figure 2-5. Data Set Interface Panel

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#### DISPLAY STATION.

Rotating the ON/OFF/INTENSITY control, located on the right side of the Display Station, toward the rear of the cabinet turns the Display Station on; further rotation increases the intensity of the displayed symbols. The ON/OFF/INTENSITY control being off does not prevent communication on the interface between the computer and the delay-line memory and does not disable keys on the keyboard, except the SHIFT key. Figure 2-6 shows the Display Station and figure 2-7 shows the Display Station keyboard.

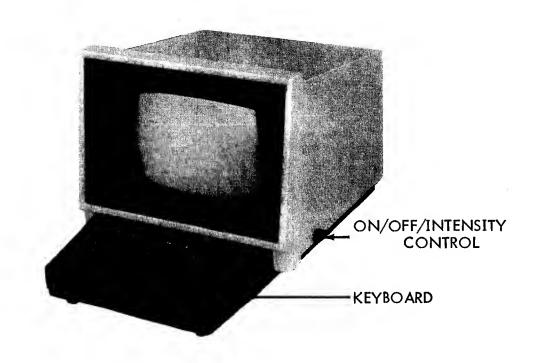


Figure 2-6. Display Station

Four rows of keys on the Display Station keyboard enter symbols into the delay line for display on the crt. Depression of a key enters the code for the symbol indicated on the key into memory at the position of the entry marker, generates the symbol on the crt, and advances the entry marker. The keyboard is inoperative during the following intervals:

- (a) SEND key is depressed until the end of a read message from or a write message to that station.
- (b) PRINT key depressed until printout is complete. The CLEAR key is not locked out during printout.



Figure 2-7. Display Station Keyboard

- (c) The station is connected and the Channel Busy signal is a logical 1.
- (d) Reset function or reset clear function is being performed by the Display Station.

The following list explains the operation of the control keys.

## Clear.

Depress the CLEAR key to clear all data from the delay line and from the crt. The entry marker moves to the upper left corner of the screen. This operation prevents sending or receiving data from the time the key is depressed until 16.8 microseconds to 20 milliseconds after the key is released. (The time variation is due to latency characteristics of the delay line).

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#### Reset.

Depress the RESET key to move the entry marker to the upper left corner without affecting data. This operation prevents sending or receiving data from the time the key is depressed until 16.8 microseconds to 20 milliseconds after the key is released.

## Shift.

Continued depression of either SHIFT key enables entry of the upper symbol on the two-symbol keys. Operation of the single-symbol keys is not affected by the SHIFT keys; all alphabetic symbols are displayed in uppercase form. The SHIFT keys are nonlocking.

## Space.

Operating the SPACE key stores a space code in the delay line at the position of the entry marker and advances the entry marker. Data is not affected.

## Skip.

Depress the SKIP key to move the entry marker one space forward. Data is unchanged.

## Repeat.

Operating the REPT key in conjunction with another key enables a repeated action of that key's character/function. CLEAR, PRINT, RESET, SEND, and SHIFT keys are not affected by the REPT key.

## Backspace.

The BKSP key moves the entry marker one space back without changing data. Backspace is accomplished in 10 milliseconds minimum to 90 milliseconds maximum, during which time no data can be transferred on the data channel.

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## Line Skip.

Depress the LINE SKIP key to advance the entry marker to the beginning of the next line. Line skip is accomplished in 151.2 microseconds minimum to 1 millisecond maximum, during which time no data is transferred between a connected Display Station and the computer.

#### Return.

Operation of the RETURN key inserts a carriage return code at the entry marker position and moves the entry marker to the first symbol position on the next line. The carriage return is displayed as a superscript dash (). The return takes from 151.2 microseconds (if the entry marker is at the end of a line) to 1 millisecond (if the entry marker is at the beginning of a line), during which time no data can be transferred between the Display Station and the computer.

## Send.

The SEND key stores an end of message symbol (elevated  $^{\Delta}$ ) at the entry marker position and moves the entry marker to the upper left corner. Data transfer is prevented during the time (16.8 microseconds minimum to 20 milliseconds maximum) the entry marker is moving.

#### Print.

Operation of the PRINT key stores an end of print code (') at the entry marker position, moves the entry marker to the upper left corner, and initiates printout of data from the upper left corner to the end of print code on an associated Printer Station. The keyboard, except for the CLEAR key, is disabled during printout. During printout, the Display Station is not ready to the computer.

## PRINTER STATION.

Figure 2-8 shows the Printer Station typewriter controls. Note the location of the ON/OFF switch to the right of the keyboard. A multipaper adjustment (top left) provides even printing for carbon copies. Remaining controls are common

to an electric typewriter and include the following: platen knobs for manually advancing the paper, a line space lever for single or double spacing, a paper release lever, left and right visible margin stops, an impression selector lever which adjusts the striking force of the typing element, a tab set and clear control, tab key, index key, shift keys, margin release, space bar, etc.

Refer to the IBM Selectric Manual supplied with the equipment for more detailed information about the typewriter.

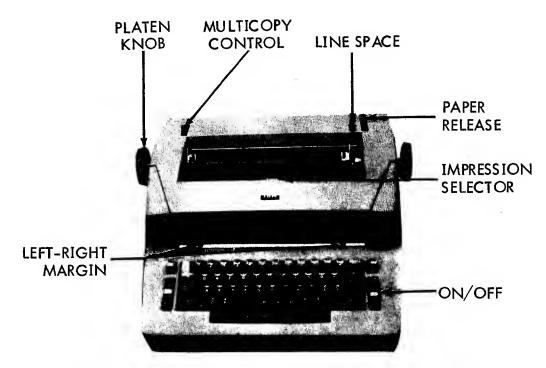


Figure 2-8. Printer Station Typewriter Controls

## OPERATING PROCEDURES.

The remainder of this section describes normal operating procedures for the display equipment. Included are turn on/turn off procedures followed by a typical operation sequence.

## TURN ON/TURN OFF.

Turn on/turn off procedures are listed in table 2-2. For precautionary measures, it is recommended the steps be followed in the order listed.

TABLE 2-2. TURN ON/TURN OFF PROCEDURES

	TABLE 2-2. TORIN ON TORIN OFF PROCEDURES				
STEP	LOCATION	OPERATION			
	TURN ON				
1	Display Controller	Place the POWER ON/OFF switch in the ON position. Move RUN/MASTER CLEAR switch to MASTER CLEAR position, then to RUN position.			
2	Display Stations	Rotate the ON/OFF/INTENSITY control to the ON position. Depress the CLEAR key. After a 30-second warmup period, rotate ON/OFF/INTENSITY control until the entry marker is visible.			
3	Printer Stations	Depress the ON/OFF rocker switch to the ON position.			
	TURN OFF				
]	Printer Stations	Depress the ON/OFF rocker switch to the OFF position.			
2	Display Stations	Rotate the ON/OFF/INTENSITY control to the OFF position.			
3	Display Controller	Place the POWER ON/OFF switch in the OFF position.			

## TYPICAL OPERATION SEQUENCE.

Figure 2-9 is a flow diagram depicting a typical operation sequence. Depress the CLEAR key on the Display Station keyboard to clear the display screen. The operator then enters data via data entry keys. When data is properly composed, it may be sent to the computer by actuation of the SEND key, or to a Printer Station, which shares memory with the Display Station, by depressing the PRINT key.

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The computer may respond to properly transmitted data by sending the requested data or a message acknowledging receipt of the transmitted data. The operator may then print the reply data, or edit it (eg, filling in information on a blank form, or updating stored data), and transmit the edited data back to the computer.

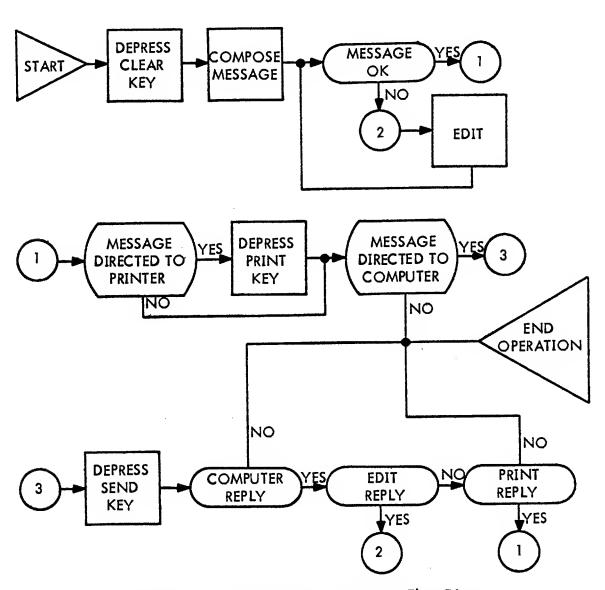


Figure 2-9. Typical Operation Sequence Flow Diagram

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#### SECTION III

#### PROGRAMMING

This section describes programming aspects of the display equipment. It provides a complete description of signals, function and status codes, interrupts, symbol data, word formats, various read/write operations, and programming aids for both interface and poller assemblies.

#### INTERFACE SIGNAL LINES.

The Display Controller operates from the standard (12 bit) 3000 Series standard communications channels. Figure 3-1 shows the interconnecting data and control lines between the computer communications channel and the Display Controller. Following is a description of each line or group of lines.

## DATA LINES (12).

There are 12 bidirectional data lines. During a read operation (input to the computer), these data lines carry data, 12 bits at a time, from the Display Controller to the computer. During a write operation (output from the computer), the data lines carry data from the computer to the Display Controller. The data lines also are used to transmit the 12-bit connect and function codes associated with Connect and Function signals, respectively.

#### PARITY LINE.

A parity bit accompanies each 12 bits of data, connect code, and function code transmitted between the computer and the Display Controller. Odd parity is used, ie, the total number of 1's transmitted is always an odd number.

#### CONNECT LINE.

A Connect signal is sent to the Display Controller when a 12-bit connect code is available on the data lines. The Display Controller connects only if the following conditions are met:

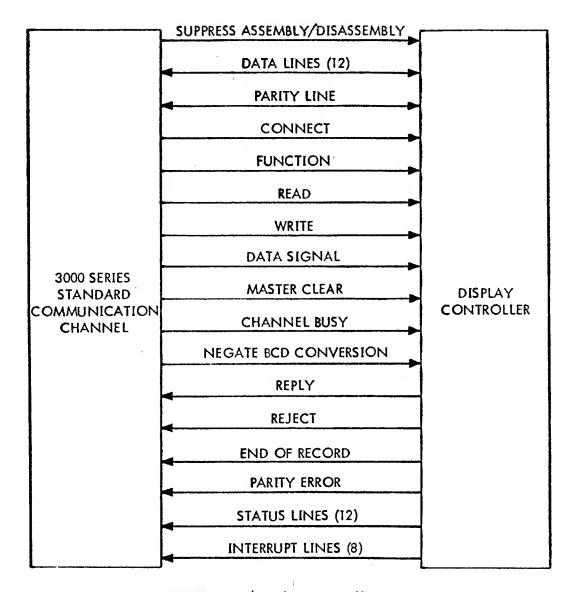


Figure 3-1. Computer/Display Controller Interface Lines

- (a) The most significant 3 bits of the connect code must match the number setting of the EQUIPMENT SELECTOR switch.
- (b) Display Controller power is on.
- (c) The RUN/MASTER CLEAR switch is in the RUN position.
- (d) Parity is correct.

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No response is returned when a parity error exists on the connect code; however, the red PARITY error indicator on the Display Controller maintenance panel (figure 2-1) lights on all Display Controllers and external equipment controllers associated with that communications channel. After a delay of 100 microseconds, the communications channel generates its own internal Reject signal.

Once a Display Controller is connected to the computer, it remains connected until the communications channel initiates a disconnect. To perform a disconnect, send any connect code with the upper 3 bits not matching the Display Controller EQUIPMENT SELECTOR switch setting, a Master Clear signal, or a release function code.

#### FUNCTION LINE.

A Function signal is sent to the Display Controller when a 12-bit function code is available on the data lines (function codes are listed under interface control codes). If the Display Controller is connected to the computer and is capable of executing the specified function at the time it receives the Function signal, it initiates the function and returns a Reply signal. If the Display Controller cannot perform the function, it returns a Reject signal. The Function signal and 12-bit function code drop when a Reply or Reject signal is returned. If a Reply or Reject signal is not returned within 100 microseconds, the computer generates its own internal reject.

The specified function is not performed if a parity error exists on the function code; however, a Parity Error signal is returned by the Display Controller and the red PARITY error indicator on the Display Controller maintenance panel (figure 2-1) lights.

Once a function code is accepted by the Display Controller, all other function codes are locked out until the first one is acted upon. The Display Controller does not hold or stack up the function codes; a Reply or Reject signal is returned within 5 microseconds. If a second function code is received which specifies the same function as the previous function code, the second function code is rejected unless the function can be performed immediately a second time.

#### READ LINE.

A Read signal transmitted to the Display Controller directs the Display Controller to begin reading data from a specified Display Station memory.

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#### WRITE LINE.

A Write signal transmitted to the Display Controller directs the Display Controller to begin writing data into a specified Display Station memory.

#### DATA SIGNAL LINE.

A Data signal is sent from the computer to the Display Controller for each 12-bit data word during read and write operations. The Data signal drops when a Reply (or End of Record) signal is transmitted by the Display Controller.

During a read operation, the Data signal indicates that the computer is ready to accept a 12-bit data word from the Display Controller. During a write operation, the Data signal indicates that the computer placed a 12-bit data word on the data lines.

#### MASTER CLEAR LINE.

A Master Clear signal sent from the computer returns the Display Controller to its initial clear condition and starts the polling operation.

#### CHANNEL BUSY LINE.

A Channel Busy signal is sent to the Display Controller when the computer communications channel is active during a read or write operation.

#### NEGATE BCD CONVERSION LINE.

When the Negate BCD Conversion signal is a logical 1, external BCD codes are used; when the Negate BCD Conversion signal is a logical 0, internal BCD codes are used. Refer to Symbol Data in this section.

#### REPLY LINE.

The Display Controller transmits a Reply signal in response to the following:

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- (a) A connect code having no parity error and containing a matching Display Controller EQUIPMENT SELECTOR switch equipment select code and proper select code.
- (b) A function code received with no parity error if the Display Controller is capable of executing the specified function at the time it receives the Function signal.
- (c) During a write operation after the Display Controller has read a data word.
- (d) During a read operation when the Display Controller has a word on the data lines (see End of Record signal for exception).

The Reply signal drops when the Connect, Function, or Data signal drops.

#### REJECT LINE.

The Display Controller transmits a Reject signal in response to the following:

- (a) A connect code (with no parity error) specifying a nonexistent or busy station.
- (b) A function code (with no parity error) specifying an illegal function.
- (c) A function code (with no parity error) which cannot be performed within 5 microseconds after receipt of the Function signal (refer to programming aids for such conditions).
- (d) An alert function to a poller that had its alert request status cleared, or an alert function to any station other than a poller.

## SUPPRESS ASSEMBLY/DISASSEMBLY LINE.

During a read operation, the Suppress Assembly/Disassembly signal forces the Display Controller to assemble logical 0's in bits 6 through 11 of each 12-bit data byte. In a write operation, bits 6 through 11 are not used when the Suppress Assembly/Disassembly line is enabled. The signal has no effect on the address word during a read operation initiated by an interrupt.

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#### END OF RECORD LINE.

The Display Controller transmits an End of Record signal (instead of a Reply signal) in response to the next Data signal following transmission of EOM signal. The End of Record signal drops when the Data signal drops. If the Read signal drops before the read operation completes, the End of Record signal is not transmitted because the remaining data is not transmitted.

#### PARITY ERROR LINE.

The Display Controller transmits a Parity Error signal when a parity error occurs on a function code or write operation. No Parity Error signal is generated for a parity error occurring on a connect code or read operation. During a write operation, a parity error on one word of a 12-bit byte results in display of both words as parity error symbols when the Suppress signal equals 0.

## STATUS LINES (12).

The Display Controller places information on the 12 available status lines following a connect operation to indicate its operating conditions to the computer. Display equipment status remains enabled to the computer until a disconnect is sent from the computer. The computer may sample the status lines at any time. Status bits are listed under interface control codes.

#### INTERRUPT LINES (8).

Each Display Controller and external equipment controller attached to a given computer communications channel is assigned to one of eight separate interrupt lines selected by the EQUIPMENT SELECTOR switch. The interrupt line indicates to the computer that a predetermined condition has been reached. The interrupting condition can be determined by program sampling the status lines following transmission of an Interrupt signal if connected.

## INTERFACE CONTROL CODES.

Interface control codes include connect, function, and status codes. The connect code is used in addressing the display equipment. Function codes, with

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the exception of reset, alert, and release, set up and remove interrupt conditions in the Display Controller. Status codes indicate what conditions exist at the Display Controller. Following is a description of the connect code, display equipment function codes, and status line assignments.

#### CONNECT CODE.

The connect code is 12 bits long and is transmitted to the Display Controller on the 12 data lines along with a Connect signal on the connect line. The Display Controller interprets the connect code (figure 3-2) as follows:

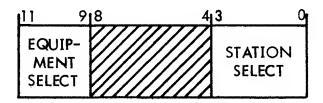


Figure 3-2. Connect Code

Bits 9 through 11 designate the number setting of the Display Controller EQUIPMENT SELECTOR switch. The station select portion of the connect code allows selection of a Display Station or poller or selection of a Display Station or poller that caused an interrupt. Bits 4 through 8 are not interpreted.

#### FUNCTION CODES.

Function codes are 12 bits long and are transmitted to the Display Controller on the data lines along with a Function signal on the function line. Table 3-1 lists and describes Display Controller function codes.

#### STATUS CODES.

Twelve status lines are available for indicating display equipment operating conditions to the computer. The computer may sample these lines at any time.

TABLE 3-1. DISPLAY CONTROLLER FUNCTION CODES

OCTAL CODE	FUNCTION	DESCRIPTION
0000	Release	Disconnects the Display Controller from the computer and clears all interrupt selections and parity error indications. Also master clears a poller if the poller is connected.
0010	Reset Entry Marker	Positions the entry marker on selected Display Station or poller to upper left corner to prepare for a read or write. The Display Station or poller indicates busy status for 3.2 microseconds to 20 milliseconds after receipt of the function. Generally precedes a write or computer-initiated read.
0011	Reset-Clear	Similar to a reset entry marker function except data is cleared from the delay line. When addressed to a poller, the function does not clear the delay line but clears existing send requests. The Display Station or poller indicates busy status for 20 to 40 milliseconds upon receipt. Generally precedes a write to local station.
0020	Select Interrupt for Ready and Not Busy (Note 1)	Allows generation of an interrupt when printer operation completes. Reselection removes an interrupt resulting from a previous selection.
0021	Clear Interrupt Enable for Ready and Not Busy (Note 1)	Removes interrupt and selection resulting from code 0020.
0022	Select Interrupt on End of Operation (Note 1)	Allows generation of an interrupt when the read or write operations or a reset or a reset clear operation completes. Reselection removes interrupt resulting from a previous operation.

TABLE 3-1. DISPLAY CONTROLLER FUNCTION CODES (CONT)

OCTAL CODE	FUNCTION	DESCRIPTION
0023	Clear Interrupt on End of Operation (Note 1)	Removes interrupt and selection result- ing from code 0022.
0024	Select Alert Interrupt	Allows generation of an interrupt upon completion of an alert message by a poller. Reselection removes an interrupt resulting from a previous operation.
0025	Clear Alert Interrupt	Clears interrupt and selection due to code 0024.
0026	Select Station Interrupt (Note 1)	Allows generation of an interrupt if a SEND key on a Display Station is depressed, if a poller receives a read message in response to a poll message or if an error is indicated. Reselection removes an interrupt resulting from a previous selection if a read or write operation is performed on the interrupting station prior to reselection. Stacking of station interrupts is possible and, if more than one station has had its SEND key depressed, another interrupt occurs immediately after reselection.
0027	Clear Station Interrupt (Note 1)	Removes interrupt and selection result-ing from code 0026.
(Note 2)	Alert Poller	Instructs connected poller to send an alert message to the addressed remote site and station. Alert occurs in the polling sequence. If the alert is sent to a local station, it is rejected.
	Note 1 — affect of	all stations simultaneously.
	Note 2 — IXXXX	XXX0011 binary.

Table 3-2 identifies status conditions, lines, and octal codes characteristic of the Display Controller. The computer may sample any single status line or group of lines.

All conditions listed in table 3-2 except send request and print request, are general status conditions; ie, the computer connects only to the Display Controller and any existing station before sampling status. Lines 0, 2, 3, 4, 5, and 10 are on a per station basis, ie, a specific station must be referred to before sampling status. Lines not listed in table 3-2 are not used.

TABLE 3-2. DISPLAY CONTROLLER STATUS CONDITIONS

LINE	OCTAL CODE	CONDITION	DESCRIPTION
0	XXX1	Ready	The Display Controller is ready when power is on and the RUN/MASTER CLEAR switch is in the RUN position. A particular station may become not ready if an operator depresses the PRINT key and the printer begins printout.
1	XXX2	Busy	The Display Controller is busy when the Channel Busy and the Read signal or Write signal is active, or when the reset or reset-clear function is executed. The Display Station keys are inoperative during a read or write operation.
2	XXX4	Send Request	Indicates on a per station basis that an operator depressed the SEND key or that a connected poller has a read message or a message in error.
3	XXIX	Print Request	Indicates on a per station basis that a print operation is requested by the station or it is performing a print operation.
4	XX2X	Poll Message Error	Indicates that the connected poller was unable to receive an expected response to a poll message in three attempts.

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TABLE 3-2. DISPLAY CONTROLLER STATUS CONDITIONS (CONT)

LINE	OCTAL CODE	CONDITION	DESCRIPTION
5	XX4X	Alert Request	A connected poller is ready to process an alert function from the computer. Any previous alert function has been processed.
6	XIXX	Station Interrupt	Indicates that a station interrupt was caused by depressing one or more SEND keys, or that a poller detected a message in error or received a read message.
7	X2XX	Ready and Not Busy Interrupt	Indicates that a ready and not busy interrupt was generated when print-out completed and that the ready and not busy interrupt was selected.
8	X4XX	End of Operation Interrupt	Indicates that an interrupt was generated by the end of a read/write operation, reset, or reset-clear function. A new function, or read or write operation may be initiated following the end of operation interrupt.
9	1XXX	Alert Interrupt	Interrupt generated by completion of an Alert message to a remote site.
10	2XXX	Poller Error	Error condition after three attempted write, clear-write, write-reset, or alert messages to a remote site from the connected poller.

# INTERRUPTS.

The interrupt permits the display equipment to indicate to the computer certain preprogrammed conditions. The computer can selectively activate or deactivate these interrupt conditions.

Four conditions generate an interrupt and four function codes enable these interrupts to the computer for the Display Controller. Table 3-3 lists the interrupt conditions, enabling functions, and disabling functions. Refer to the specific enabling function code (table 3-2) for a complete description of the interrupt condition.

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INTERRUPT	FUNCTIO	N CODE
INTERROFT	ENABLE	DISABLE
Ready and Not Busy	0020	0021
End of Operation	0022	0023
Alert	0024	0025
Station	0026	0027

TABLE 3-3. DISPLAY CONTROLLER INTERRUPTS

The computer must first connect to a specific Display Station before issuing any interrupt enable function codes. Normally, status is checked immediately following the connect. If the computer desires to perform a reset operation (function code 0010), or a read or write operation, and wants to be informed when the operation is completed, it transmits function code 0022 (interrupt on end of operation) prior to the operation.

An end of printout operation can interrupt the computer if the ready and not busy interrupt is enabled. After connecting to a specific Display Station and finding the station busy executing a printout, the computer has the option to discontinue the printout or select the interrupt on ready and not busy condition (function code 0020). Even though the function code is directed to a specific Display Station, it enables a station interrupt from any Display Station satisfying the ready and not busy condition.

If the computer wants to receive the data from a local Display Station, function code 0026 (station interrupt enable) is transmitted. An interrupt transmits when the SEND key on this station, or any other Display Station, is depressed.

Upon receiving an interrupt from the display equipment, the computer normally connects to the Display Controller and samples status to determine what caused the interrupt. It can immediately perform a read operation following a connect word having a select code 0000 if the interrupt is a station interrupt. A write operation or other interrupt requires connecting to a specific station before beginning the operation. After servicing an interrupt, the interrupt line may be cleared by reselecting or deselecting the same interrupt except station interrupt.

### SYMBOL DATA.

The display equipment symbol repertoire includes the alphabet in uppercase, arabic numerals (0 through 9), punctuation marks, and special symbols.

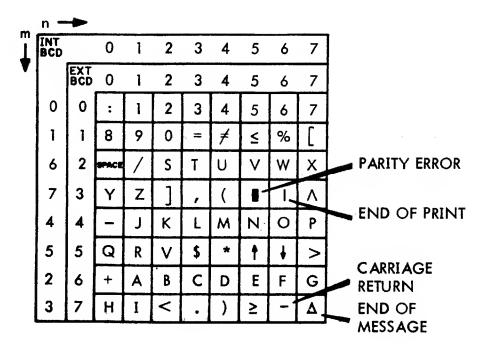
Table 3-4 presents the Display Controller symbol repertoire in alphabetic and numeric order. Figure 3-3 shows two quick reference charts for locating a

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TABLE 3-4. SYMBOL REPERTOIRE

•			TABLE 3-4.	J   141	DOL 1		O1112		
	ВС	D	CVAROL	ļ	BC		SYMBOL	BC	
SYMBOL	EXT	INT	SYMBOL		EXT	INT	31MBCE	EXT	INT
Α	61	21		Х	27	67	Çomma ,	33	73
В	62	22		Υ	30	70	Left paren (	34	74
С	63	23		Z	31	71	Parity error	35	75
D	64	24	Colon	:	00	12	End of	36	76
E	65	25		1	01	01	print (Note)	37	77
F	66	26		2	02	02	Logicar On	40	40
G	67	27		3	03	03	Tiyphon	52	52
н	70.	30		4	04	04	Logical AND	32	32
I	71	31		5	05	05	Dollar sign \$	53	53
J	41	41		6	06	06	Asterisk *	54	54
К	42	42		7	07	07	Arrow up	55	55
L	43	43		8	10	10	Arrow down	56	56
М	44	44		9	11	11	Greater than >	57	57
N	45	45		ø	12	00	Plus +	60	20
0	46	46	Equal	=	13	13	Less than <	72	32
Р	47	47	Not equal	7	14	14	Period .	73	33
Q	50	50	Less than or equal to	≤	15	15	Right paren )	74	34
R	51	51		%	16	16	Greater than	75	35
\$	22	62	Percent	r	17	17	or equal to		
Т	23	63	Left bracket	L ace	20	60	Carriage return (Note)	76	36
U	24	64	Right diagona		1	61	End of $\Delta$	77	37
V	25	65	N	_	32	12	message		
W	26	66	Right bracket	ل					
1		Naka	diamlayad	<b>a</b> s s	unarca	rint	does not print.		

Note — displayed as superscript, does not print.



#### NOTE:

00 internal BCD equals 12 external BCD 00 external BCD equals 12 internal BCD

Figure 3-3. Symbol Code Quick Reference Chart

symbol when given the 6-bit octal or BCD code. A two-digit code of the form m/n uniquely specifies each code, eg, external BCD code 65 represents the letter E.

Standard display format is 20 lines of 50 symbols per line with an optional display format of 13 lines of 80 symbols available. The Display Station INTENSITY/ON/OFF switch adjusts symbol intensity. Symbol size is adjustable internally and is normally set to generate symbols 1/8-inch wide by 1/4-inch high.

### WORD FORMATS.

The display word format is 6 bits. Each 6-bit word specifies a symbol code or control code as listed in the symbol repertoire table.

Besides the display word format, there are five 12-bit interface word formats. The connect, function, data, and station word are transmitted on the data lines and are identified by a signal transmitted on a corresponding signal line. The status word is enabled to the computer on the status lines whenever the Display Controller is connected to the computer.

Table 3-5 lists all word formats and identifies the distinguishing signal where applicable.

SIGNAL **FORMAT** WORD Display CODE EQUIP-STATION MENT Connect Connect SELECT SELECT **Function Function FUNCTION CODE** Data Data SYMBOL SYMBOL 1 Status STATUS CODE REMOTE REQUESTING REMOTE Data Station STATION STATION SITE CODE CODE CODE Alert REMOTE REMOTE **Function** 0011 STATION **Function** 

TABLE 3-5. WORD FORMATS

The connect word contains information which directs the Display Controller to connect the computer data channel to the designated Display Station or poller. Bits 9 through 11, the equipment select code, designates the equipment number which may be chosen on the EQUIPMENT SELECTOR switch. Bits 0 through 3 (the station select code) are used to select the specific local Display Station or poller with which the computer is to communicate. A station select code of 0001 through 1100 binary designates the corresponding numbered Display Station or poller. A station select code of 0000 binary indicates that the computer requests a check of status conditions, or requests to communicate with the lowest numbered Display Station causing an interrupt. If no interrupt is present, connection is prevented.

Figure 3-4 shows the sequence of events upon receipt of a Connect signal. If the Display Controller is in a ready state, parity is checked upon receipt of the Connect signal. A parity error at this time illuminates the PARITY indicator and the display equipment disconnects in approximately 1 microsecond. Assuming parity is correct, the EQUIPMENT SELECTOR switch setting is compared to the equipment select code. If the two do not compare, a disconnect is performed in about 1 microsecond. An exact comparison allows the status lines to be enabled. After comparing the equipment select code, the Display Controller examines the station select code to see if it is addressing an existing Display Station or poller. If the device is non-existent or busy, a Reject signal is transmitted to the computer no sooner than 2 microseconds after the condition is detected. Assuming the Display Station or poller exists and is not busy, the Display Controller responds with a Reply signal in about 2 microseconds.

If the station select code contains all 0's and an interrupt condition is not pending, a Reject signal is sent to the computer. An interrupt condition at this time draws a Reply signal response from the Display Controller and the interrupting Display Station or poller is connected. The computer then reads at least one word (the station word) and normally continues the read operation until all of that station's data is read. If the interrupt condition is nonexistent, a connect is made to the Display Controller for reading Display Controller status only. No read or write operation is performed.

Once connected, the Display Controller is ready to perform any function desired by the computer in addition to a read or write operation. Figure 3-5 shows the sequence of events upon receipt of a Function signal. If the Display Controller is not connected, it takes no action in response to a Function signal.

An assembly/disassembly register in the Display Controller handles packing and unpacking chores for read and write operations respectively. The most significant 6 bits of the data word are always filled or emptied first. If the computer enables the Suppress Assembly/Disassembly line, the most significant 6 bits would

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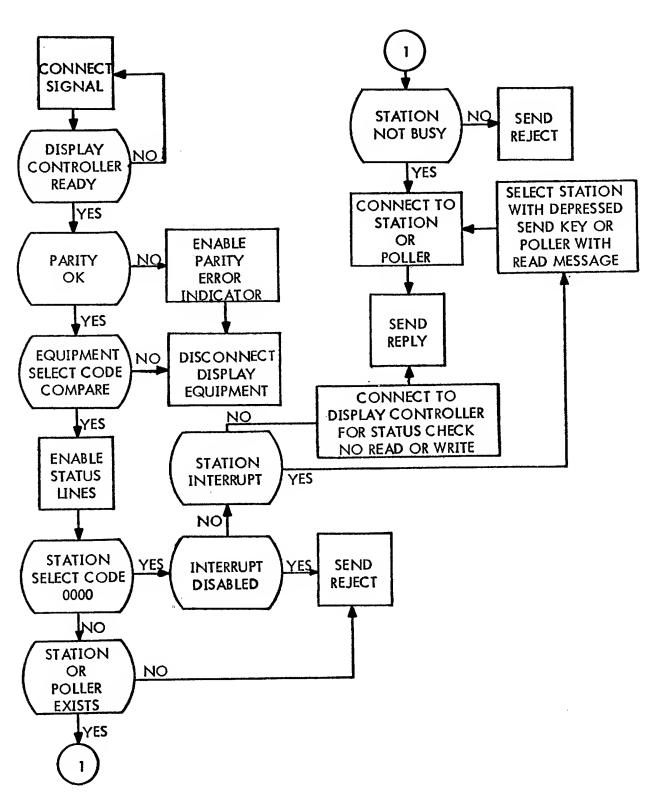


Figure 3-4. Connect Sequence

82 12 29 00 3 - 17

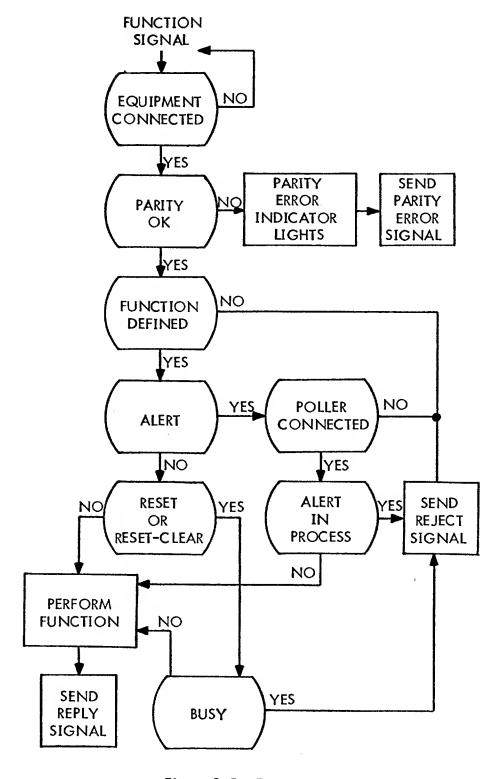


Figure 3-5. Function Sequence

neither be filled or emptied for the duration of the signal. The least significant 6 bits are unaffected; therefore, data transmission takes place in the form of one 6-bit word at a time.

# READ/WRITE OPERATIONS.

Read or write operations to or from a local Display Station may be performed any time at the discretion of the computer, after checking status. The computer-initiated action takes priority over the operator. If a read or write operation is initiated during a period when an operator is composing a message from the keyboard, the operator's keyboard is locked out and computer operation takes over. A read or write operation to a Display Station performing a printout results in termination of the printout and the read or write operation is performed at the specified Display Station.

The Display Controller allows the computer to enable an interrupt on an end of printout condition. Following connection to a specific Display Station and sampling status, print request status (line 3) is enabled if the Display Station requests a print operation or if it is presently performing a printout. Not ready status indicates the Display Station is actually performing a printout. Using function code 0020 octal, the computer may enable the select interrupt on ready and not busy condition. Upon completing printout, an interrupt is sent to the computer and status line 7 (ready and not busy interrupt) is made active. The 0020 function code enables an interrupt to generate when any Display Station completes printout.

Computer read and write operations do not take priority in the poller. The poller scans the remote stations to determine if a SEND key is depressed. If this condition exists, the selected station transmits a read message to the poller. After storing the message in memory, the poller generates a send request and the computer responds with a read operation. In response to the read message, the computer must send a write message to the selected poller. The poller then relays this message to the remote station.

The alert function turns on the ALERT light and audible alarm at the remote station; the SEND key must be depressed to turn them off. The subsequent read message enables the computer to perform a write operation.

Read operations may be initiated from the local or remote Display Stations by an operator depressing the SEND key or from the computer by programmed instructions (local Display Station only). A write operation is initiated only from the computer. Following is a description of read and write operations.

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# READ OPERATION INITIATED BY A REQUESTING STATION.

A requesting station is a local Display Station at which a SEND key was depressed, or a poller which received a read message from a remote station. At a requesting station an end of message symbol is inserted at the entry marker position, the entry marker is moved to the upper left corner, and a station interrupt is initiated if the station interrupt is enabled by the computer. The computer responds to the interrupt with a connect word containing a station select code of 00 octal. The Display Controller then connects to the requesting station in scanning sequence and activates the status lines. The computer must perform a read operation to clear the send request. If a read operation is not performed, the station interrupt is sent again upon receipt of the station interrupt enable.

The station word (shown in table 3-5), containing the number of the scanner selected requesting station, is sent in response to the first Data signal during a station-interrupt initiated read operation. If the selected requesting station is a poller, the remote site and station are indicated in bits 4 through 10. Successive words after the station word contain data stored in the delay line starting at the entry marker position.

When the end of message code is detected, it is sent to the computer in a data word. In response to the next Data signal following an end of message code, the End of Record signal accompanied by an all-zero data word is sent instead of the Reply signal. The Read signal terminates the read operation and becomes disabled for more than 200 nanose conds. Data may therefore be read beyond the end of message code if the Read signal remains enabled. Figure 3-6 shows simplified read operation timing.

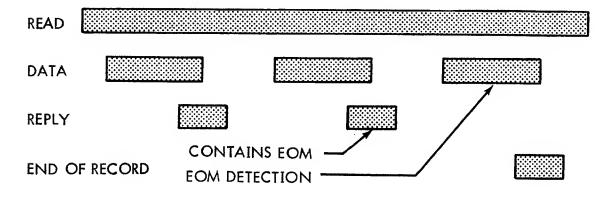


Figure 3-6. Simplified Read Timing

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If successive read operations are performed without resetting the entry marker (such as repetitive one-word reads) one symbol is lost each time the Read signal is dropped.

# READ OPERATION INITIATED BY THE COMPUTER.

The computer may initiate a read operation at any time the connected local Display Station or poller is not busy. Discretion is required in the use of this operation since it prevents entry of data by a Display Station operator. After connecting, the entry marker may be moved to the upper left corner by the reset function or may be left at its current position. In response to the Read and Data signals, data words are sent along with the Reply signal. A read operation performed on a connect to a specific station does not send the station word.

# WRITE OPERATION TO A LOCAL DISPLAY STATION.

Data may be written into a connected station at any time the station is not busy. After connecting and checking status, the computer sends data words to be written on the crt starting at the position of the entry marker. A reset or reset-clear function may move the entry marker to the upper left corner before writing data. Sequential symbols in data words are written from left to right and from top to bottom on the crt. After the last symbol is written in the lower right corner, the entry marker moves to the upper left corner and data writing may continue, with the later data replacing data written earlier. Figure 3-7 shows simplified write operation timing.

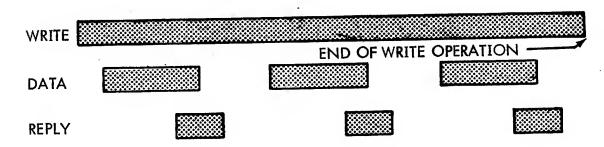


Figure 3-7. Simplified Write Timing

#### WRITE OPERATION TO A POLLER.

Data is always transferred to a poller after a read operation from the poller. After connecting to the poller and checking status, the computer sends data words

to be written into the poller memory starting at the position of the entry marker. The entry marker is always at start-of-memory after any computer read operation.

A reset function immediately preceding a write to the poller results in a write-reset message from the poller to the remote station; a reset-clear function results in a clear-write message. No function results in write message. Sequential symbols in data words are written into the poller memory. The poller is informed that it is to send the message when the Write signal drops. The write, write-reset, or clear-write message is sent to the remote station which had just previously sent a read message.

# PROGRAMMING AIDS.

Following are several points concerning display equipment timing:

- (a) The Display Controller is busy for 33 microseconds after the last Reply signal is sent at the end of a write operation.
- (b) The Display Controller is busy from 3.2 microseconds to 20 milliseconds after receipt of a reset function.
- (c) If a read or write operation follows a reset function which transmits an interrupt upon completion, 20-millisecond delay (after the end of operation interrupt is sent) occurs before the first data word is stored or read from memory.
- (d) One symbol time is 16.8 microseconds. Each data word contains two symbols and requires 33.6 microseconds. The delay-line memory cycle time is 20 milliseconds. During a read or write operation, successive data words must follow within 33.6 microseconds (time required to read or write two symbols) or a 20-millisecond delay occurs between bytes due to delay line latency characteristics.

# PROGRAMMING RESTRICTIONS.

- (a) It is necessary to read at least two 12-bit words to clear the send ff when a connect is issued after an interrupt.
- (b) There should not be any unsolicited read or write operations (poller only).
- (c) Sending an end of print message to a Display Station initiates operation of its associated Printer Station(s).

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## POLLER TRANSLATION.

The poller converts all codes and signals to a format which is compatible with Data Set operation. Signals transmitted between the poller and the Data Set meet or exceed the minimum of EIA Standard RS-232. A negative voltage of greater than -6 volts represents a logical 1; a positive voltage greater than +6 volts represents a logical 0. Half duplex, 2- or 4-wire operation, DATA-PHONE Data Set 201A or 201B service is required. Private communications lines are necessary and no provision is made for automatic ringing or answering.

A single-phase, 120-volt, 60-Hz, three-wire outlet from the Display Controller is supplied for the Data Set, so the same ground bus is used for both. This measure is necessary to prevent impulse noise potentials which might otherwise develop and cause data errors.

The poller sends and receives data in an 8-bit code which is transmitted serially over Send Data and Receive Data lines. These bits are synchronized with the Serial Clock Receive and Serial Clock Transmit signals. Data Set 201A operates at 2000 baud, Data Set 201B at 2400 baud.

# INTERFACE SIGNALS.

Figure 3-8 shows interface signals between the Data Set and the poller. The arrows indicate signal origin. Following paragraphs provide an elaboration on the signals shown in figure 3-8.

#### Send Data.

The Send Data signal originates in the poller and contains serial data. Positive polarity represents a logical 0 and negative polarity represents a logical 1. Data bits are provided to the Data Set at the time of positive transition of the Serial Clock Transmit signal.

# Request to Send.

The poller makes the Request to Send signal positive when a transmit operation is desired. Placing a negative potential on the line returns the Data Set to a receive condition.

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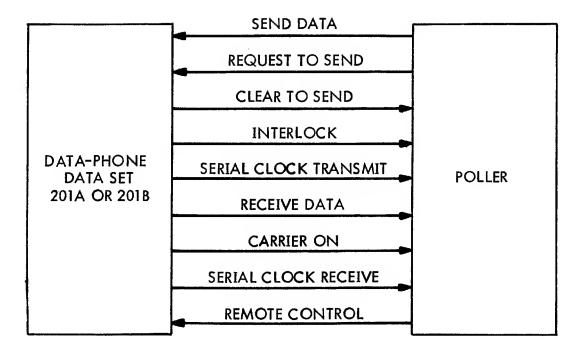


Figure 3-8. Poller Interface Signals

#### Clear to Send.

The Data Set makes the Clear to Send signal positive in response to a Request to Send signal from the poller. The amount of time elapsed between the leading edge of the Request to Send and the leading edge of Clear to Send is determined by the Data Set strapping options. The Data Set makes the Clear to Send signal negative when the Request to Send signal drops.

### Interlock.

A +6 volts on the Interlock Line indicates that the Data Set is ready to send or receive data. A 0-volt signal indicates that the Data Set is not in an operating condition.

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### Serial Clock Transmit.

The Serial Clock Transmit signal is a symmetrical square wave of +6 volts to -6 volts amplitude originating in the Data Set which is used to synchronize the acceptance of data by the Data Set. Data is placed on the Send Data line at the time of the positive transition of the Serial Clock Transmit signal and is sampled by the Data Set at the time of negative transition.

#### Receive Data.

The Receive Data signal contains serial binary data which is synchronized with the Serial Clock Receive signal. Positive polarity is defined as a logical 0 and negative polarity as a logical 1.

### Carrier On.

A positive potential at the Carrier On terminal indicates that the Data Set is receiving the carrier. A negative potential indicates that no carrier is being received. The Carrier On signal changes from negative to positive within 9 milliseconds after carrier appears at the receiver terminal.

#### Remote Control.

A positive potential indicates that the poller is ready to communicate with the Data Set.

#### Serial Clock Receive.

The Serial Clock Receive signal is a symmetrical square wave of +6 volts to -6 volts amplitude. The square wave is synchronized with the receiver timing circuits. Data bits on the Receive Data line are initiated synchronously with the positive transition of the Serial Clock Receive signal and are sampled at the negative transition.

#### POLLER CONTROL CODES.

The basic poller codes are eight bits long and are used for communication between the poller and the remote sites. The most significant bit, which is received last serially, is the parity bit. Parity is odd. The following paragraphs list poller codes. Table 3-6 lists control codes and their octal translation.

TABLE 3-6. CONTROL CODES

DESCRIPTION	7-BIT OCTAL TRANSLATION
Start of Message (SOM)	001
USASCII End of Message (USASCII EOM)	003
Poll	005
Acknowledge (ACK)	006
Alert	007
Reset-Write	014
Write	021
Clear-Write	022
Read	023
Synchronization (SYNC)	026
Reject	030

#### Start of Message.

The start of message code indicates that the next 7-bit word contains the site address. The start of message code follows the synchronization codes. It is both initiated and received by the poller.

### Alert.

The poller initiates the alert code when instructed by the computer. The alert code designates a message which turns on the ALERT light on the addressed remote site Display Station.

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### USASCII End of Message.

The USASCII end of message code indicates that the previous word was the last word of data. The word following the USASCII end of message code is the message parity word. This code is both initiated and received by the poller.

## Message Parity.

Message parity is applicable from the start of message through the USASCII end of message code, and excludes all sync codes. The message parity code is odd. The parity bit is excluded.

### Poll.

The poller initiates the poll code which designates the poll message. The poll message instructs the remote site to respond with a read message if a SEND key has been depressed or a read request active is set or a reject message if the above two conditions do not exist.

# Acknowledge.

The acknowledge code originates at a remote site and designates a message which acknowledges receipt of a write, reset-write, clear-write, or alert message with no errors.

#### Reset-Write.

The poller transmits the reset-write code when instructed by the computer. The code designates a message which instructs the addressed display equipment to write data starting at the upper left corner. The reset-write code is followed by 12 sync codes to allow time for the entry marker to reset.

#### Write.

The poller initiates the write code when instructed by a computer message. The message contains data to be written on the remote crt starting at the current entry marker position.

### Clear-Write.

The poller initiates the clear-write code when instructed by the computer. This code designates a message which instructs the addressed Display Station to clear data from the crt and write the contained data starting at the upper left corner. The poller transmits 12 sync codes following the clear-write code to allow time for the entry marker to reset.

#### Read.

The read code originates at a remote site and designates a message containing data on the Display Station crt which is to be sent to the computer.

## Synchronization.

The poller receives and transmits the sync code. Four sync codes are transmitted at the beginning of each message to assure receiver synchronization. These codes are not considered for purposes of message parity.

Sync codes also act as synchronization idles when contained within the message structure (reset-write and clear-write).

# Reject.

The reject code originates at a remote site. This code designates a message which informs the poller that a SEND key was not depressed, a read request active was not set before receipt of the poll message, or because of a busy condition, a write, reset-write or clear-write was rejected.

#### SYMBOL SUBSET.

The symbol subset codes (codes with bit 5 or 6 a logical 1, but not both) are stored in the delay-line memory and specify data presented or are displayed on the crt of a Display Station at a remote site. These codes are the data sent in read, write, reset-write, and clear-write messages.

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An escape code (76) followed by any code other than carriage return, E1, E2, or E3 codes will be converted to a space code (20 external BCD or 60 internal BCD). Refer to tables 3–7 and 3–8.

INTERNAL **EXTERNAL ESCAPE CODE RECEIVED** CODE CODE 76 76 01 (CR) 36 76 02 (E1) 37 77 76 40 (E2) 76 36 35 76 41 (E3) 75

TABLE 3-7. SYMBOL SUBSET CONVERSION TO COMPUTER

TABLE 3-8. SYMBOL SUBSET CONVERSION FROM COMPUTER

INTERNAL BCD	EXTERNAL BCD	ESCAPE CODE SENT
36	76	76 01 (CR)
37	<i>7</i> 7	76 02 (E1)
76	36	76 40 (E2)
75	35	76 41 (E3)

#### Station Address.

The station address code designates the remote site Display Station to which a poller is communicating. The station address in a read message is retained by the poller and sent to the computer. The next write, reset-write, or clear-write message from the computer to the poller is automatically sent to the Display Station from which the read message was received.

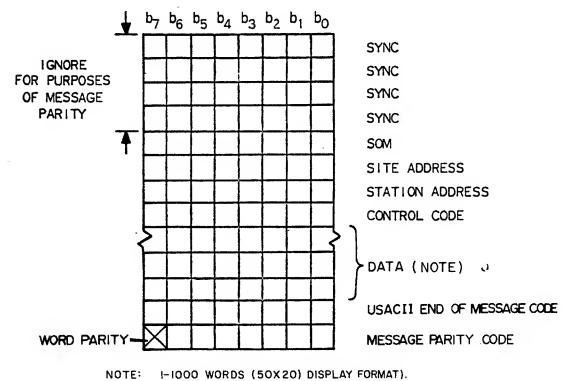
#### Site Address.

The site address code designates the remote site to which a message is addressed or from which a message is received. The remote sites polled are designated by site address switches on the Display Controller auxiliary maintenance panels. Polling takes place in numerical order.

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#### MESSAGE FORMAT.

Messages received and sent by the poller consist of several codes. The general message format is shown in figure 3-9. All messages transmitted are preceded by four sync codes to assure synchronization recovery on the receiving end. The start of message code designates that the next code is the first word of the message. The site address and station address follow in that order. The control code defines the command or data which follows. Data to or from a remote Display Station may consist of 1 to 1040 words. The USASCII end of message code designates that the previous word was the last word of the message. The message parity code follows the end of message code. Message parity is applicable from the start of message through the end of message code inclusive and excludes all sync codes. Specific messages sent and received are listed in tables 3-9 and 3-10.



I-1040 WORDS (80X13) DISPLAY FORMAT).

Figure 3-9. General Message Format

# Synchronization.

After the Data Set turns on the Carrier On signal, data input from the Data Set is fed into a buffer register. After each data bit is received, the contents of the buffer register is examined to determine if the code is a sync code. When two

TABLE 3-9. MESSAGES SENT BY THE POLLER

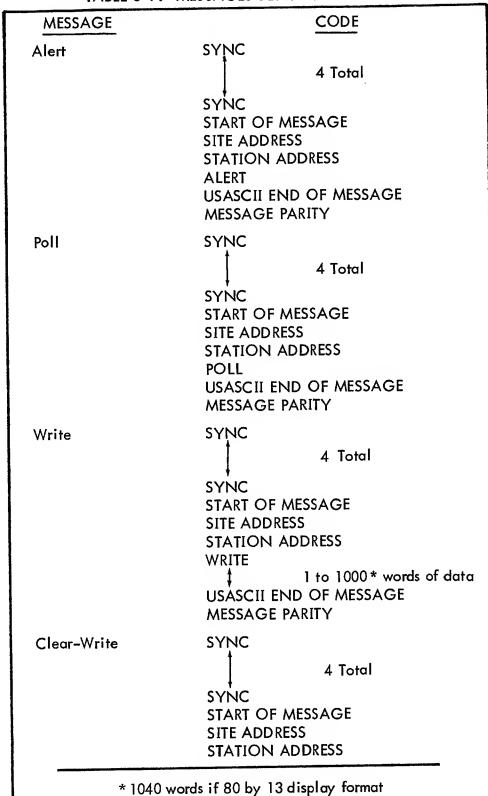


TABLE 3-9. MESSAGES SENT BY THE POLLER (CONT)

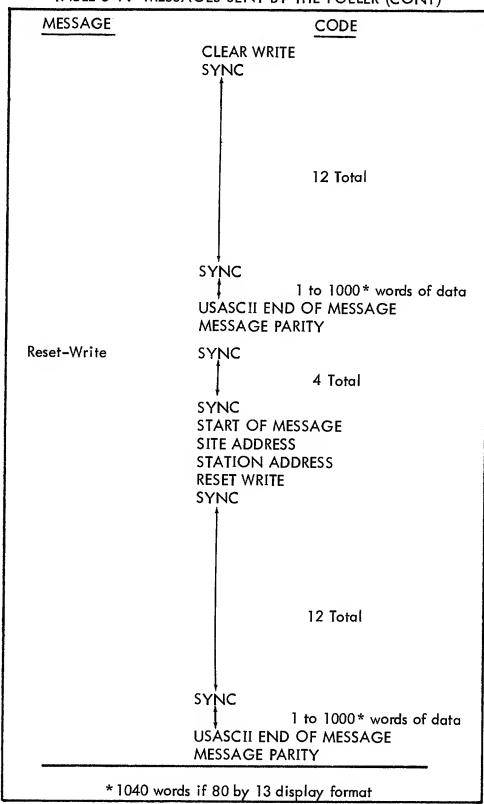
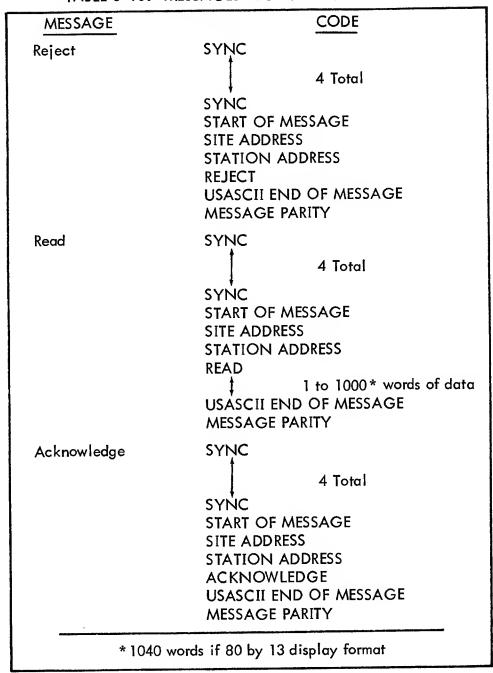


TABLE 3-10. MESSAGES RECEIVED BY THE POLLER



consecutive sync codes are detected, the poller assembles the next 8 bits and examines the contents to detect the start of message code. Unless at least two successive sync codes followed by a start of message code are detected, the poller again searches for the same pattern.

## Alert Message.

The computer cannot directly send a write, reset-write, or clear-write message to be written on a remote Display Station. It can indicate to a remote display equipment that the computer has a message to be written by initiating an alert message. The alert message is initiated by the computer as an alert function to the poller.

At the time the poller would normally poll a site, it determines if an alert function was received for that site. The poller then sends an alert message instead of a poll message. The remote Display Station, upon receipt of an alert message, lights the ALERT indicator and responds with an acknowledge message. Operator action (depress SEND key) is necessary before a write message can be sent.

# Polling.

The following description of the poller operation assumes that no error occurred while being transmitted over the DATA-PHONE and that the remote site is operating properly.

The poller is normally in a poll status during which time it sends periodic and sequential poll messages to the sites. If a SEND key is depressed at a site, the remote display equipment responds with a read message. If a SEND key is not depressed, the remote display equipment responds with a reject message. If a read message is received, it is transferred to the computer as a message from a local station would be transferred. The poller responds with a reset-write, write, or clear-write message addressed to the Display Station at which the SEND key was depressed. The poller sends the message to the remote Display Station. The remote display equipment responds to the reset-write, write, or clear-write message with an acknowledge message which completes the communication.

# Reject Message.

The reject message is a reply from a remote site to a poll message indicating that a SEND key was not depressed. The reject message also is used to inform the poller that the previous write, clear-write, reset-write or alert function was not performed. The poller interprets this as an error.

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### Read Message.

The read message is a reply from a remote site to a poll message indicating a SEND key was depressed. The data, read from the crt, begins at the upper left corner and terminates with the data subset end of message code. The read message enables send request status and the station interrupt. The computer then reads the site address and station address in the station word. After reading the station word, the computer may continue to read the rest of the data in the message or may send a write message immediately. The computer reading a data word clears the send request.

### Write Message.

The write message contains data from the computer to be written on the crt of a remote Display Station, starting at the present or reset entry marker position. A write, reset-write, or clear-write message is always sent in reply to a read message (with correct parity) from a remote site. After receiving a write message with correct channel parity from the computer, the poller switches to transmit and transfers the data to a remote site.

#### Acknowledge Message.

If the message is an acknowledge in response to an alert message, alert request and poll interrupt status are set. The computer, upon reading status, is informed that the alert message was received by the remote Display Station. An acknowledge response to a write, reset-write, or clear-write message turns the site indicator off and the polling resumes.

#### ERROR PROCESSING.

Errors may arise between the sending of a message to a remote site and receiving a message from a remote site. The poller recognizes these errors:

- (a) Lack of response before time out.
- (b) Parity error in a received message.
- (c) An unexpected response such as a read message in response to a write message.

Any one of the error conditions causes the message to be retransmitted. The message is transmitted up to three times in attempting to get an error-free response. If, after three transmissions, an error-free response cannot be obtained, the poller ceases trying to communicate with that remote site.

If three attempts to successfully communicate an alert message to a remote display equipment fail, the Interrupt signal is enabled and the poller resumes polling. When the computer selects the poller, poll interrupt, poller error, and alert request status are indicated.

Three unsuccessful attempts to communicate a write, write-reset, or clear-write message to a remote site results in an Interrupt signal. Selection of the poller indicates poller error, station interrupt, and send request status. The computer must then read the station word. The computer may reread the station word, if it contained a parity error, by reconnecting to station 0. In order to clear the status bits and resume polling, it is necessary that the computer send a release function.

If a poll message cannot be successfully communicated in three attempts, the Interrupt signal is, again, enabled. When the poller is connected, it indicates send request, poll failure, and station interrupt status. The computer then reads the station word.

#### POLLER SYMBOL REPERTOIRE.

The poller communicates with a 7-bit code plus parity. The least significant bit (bit 0) is received first, and bit 7 is parity.

Codes with bit 6 or bit 5 (but not both) a logical 1 are stored in the delay-line memory associated with the connected poller. These codes are the data sent in read, write, reset-write, and clear-write communications with the remote sites. Remaining codes specify various functions, site address, and station address. Figure 3-10 lists symbol and function codes according to their binary translation.

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				NOI	E 1		DATA S	UBSET			
			b <sub>6</sub>	0	0	0	0	1	1	1	1
			ь <sub>5</sub>	0	0	1	1	0	0	1	1
ь <sub>3</sub>	ь <sub>2</sub>	ь	مُرِّدُ	0	1	0	1	0	1	0	1
0	0	0	0			- MINUS	+	COLON	BLANK	STATION ADDRESS ON POLL	0
0	0	0.	1	SOM	WRITE	J (E3)	A	(CR)	1	1	<u>,     </u>
0	0	1	0		CLEAR- WRITE	к	В	2 (E1)	S	2	2
0	0	1	1	U5 ASCI1 EOM	READ	L	С	3	т	3	ADDRESS
0	1	0	0			м	D	4	U	4	SITE AD
0	1	0	1	POLL		N	E	5	v	5	5
0	1	1	0	ACK	SYNC	0	F	6	w	9 DRESS	6
0	1	1	1	ALERT		Р	G	7	х	STATION ADDRESS	7
1	0	0	0		REJECT	Q	н	8	Y	ω STA	
1	0	0	1			R	1	9	z	9	
1	0	1	0			V	<	ø	]	10	
1	0	1	1			s	PERIOD	=	CONTMA	11	
,	1	0	0			•	)	<i>‡</i>	(	12	ļ
1	1	0	1			1	≥	≤			
1	1	1	0			1	ESCAPE	%			
1	1	1	1			>			٨		

#### NOTES:

Figure 3–10. Symbol and Function Codes, Binary Translation

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Set aside for USASCII control codes.
 The lower portion of the four two-symbol data subset blacks are the interpretation of the codes when they immediately follow an escape code.

TABLE 1A-1. POWERS OF 2

```
2-"
                  0
                    1.0
              2
                  1
                     0.5
              4
                  2
                     0.25
              8
                  3
                     0.125
             16
                  4
                     0.062 5
             32
                     0.031 25
                  5
             64
                  6
                     0.015 625
            128
                  7
                     0.007 812 5
            256
                  8
                     0.003 906 25
            512
                     0.001 953 125
          1 024
                     0.000 976 562 5
                 10
          2 048
                     0.000 488 281 25
          4 096
                     0.000 244 140 625
                 12
         8 192
                 13
                     0.000 122 070 312 5
                     0.000 061 035 156 25
         16 384
                 14
         32 768
                     0.000 030 517 578 125
                 15
         65 536
                 16
                     0.000 015 258 789 062 5
                     0.000 007 629 394 531 25
        131 072
                 17
                     0.000 003 814 697 265 625
        262 144
                 18
                     0.000 001 907 348 632 812 5
        524 288
                 19
      1 048 576
                 20
                     0.000 000 953 674 316 406 25
                     0.000 000 476 837 158 203 125
     2 097 152
                 21
                     0.000 000 238 418 579 101 562 5
      4 194 304
     8 388 608
                 23
                     0.000 000 119 209 289 550 781 25
                     0.000 000 059 604 644 775 390 625
     16 777 216
                 24
                     0.000 000 029 802 322 387 695 312 5
     33 554 432
                 25
                     0.000 000 014 901 161 193 847 656 25
    67 108 864
                 26
                     0.000 000 007 450 580 596 923 828 125
   134 217 728
                 27
                     0.000 000 003 725 290 298 461 914 062 5
   268 435 456
                 28
                     0.000 000 001 862 645 149 230 957 031 25
   536 870 912
                 29
                     0.000 000 000 931 322 574 615 478 515 625
 1 073 741 824
                 30
                     0.000 000 000 465 661 287 307 739 257 812 5
 2 147 483 648
                 31
                     0.000 000 000 232 830 643 653 869 628 906 25
 4 294 967 296
                 32
                     0.000 000 000 116 415 321 826 934 814 453 125
 8 589 934 592
                 33
                     0.000 000 000 058 207 660 913 467 407 226 562 5
 17 179 869 184
                 34
                     0.000 000 000 029 103 830 456 733 703 613 281 25
 34 359 738 368
                 35
                     0.000 000 000 014 551 915 228 366 851 806 640 625
 68 719 476 736
                 36
                     0.000 000 000 007 275 957 614 183 425 903 320 312 5
137 438 953 472
                 37
                     0.000 000 000 003 637 978 807 091 712 951 660 156 25
                 38
274 877 906 944
                     0.000 000 000 001 818 989 403 545 856 475 830 078 125
549 755 813 888
                 39
```

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TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 1 OF 4)

	0	1	2	3	4	5	6	7		0	1	2	3	4	5	6	7		
0000	0000	0001	0002	0003	0004	0005	0006	0007	0400	0256	0257	0258	0259	0260	0261	0262	0263	0000	0000
0010	0006	0009	0010	0011	0012	0013	0014	0015	0410	0264	0265	0286	0267	0268	0289	0270	0271	to	to
0020	0018	0017	0016	0019 0027	0020 0026	0021 0029	0022 0030	0023	0420	0272 0 <b>28</b> 0	0273 0281	0274 0282	0275 0263	0276 0284	0277 0285	0278 0286	0279 0267	0777	0511
0030	0024	0025 0033	0026 0034	0027	0036	0029	0038	0039	0448	0268	0289	0290	0291	0292	0293	0294	0295	(Octal)	(Decima
0050	0040	0041	0042	0043	0044	0045	0046	0047	0450	0296	0297	0298	0299	0300	0301	0302	0303		
0060	0048	0049	0050	0051	0052	0053	0054	0055	0460	0304	0305	0306	0307	0308	0309	0310	0311		0
0070	0056	0057	0056	0059	0080	0081	0062	0063	0470	0312	0313	0314	0315	0316	0317	0316	0319	Octal	Oecima
0100	0064	0065	0066	0067	0066	0069	0070	0071	0500	0320	0321	0322	0323	0324	0325	0326	0327		- 4096 - 8192
0110	0072	0073	0074	0075	0076	0077	0078	0079	0510	0326	0329	0330	0331	0332	0333	0334	0335		- 12266
0120	0080	0081	0082	0083	0084	0085	0086	0067	0520	0338	0337	0338	0339	0340	0341	0342	0343		- 16364
0130	0086	0089	0090	0091 0099	0092 0100	0093 0101	0094	0095	0530 0540	0344 0352	0345 0353	0346 0354	0347 0355	0348 0356	0349 0357	0350 0358	0351 0359	l .	- 20480
0140 0150	0098	0097 0105	0098 0106	0107	0108	0109	0110	0111	0550	0360	0361	0362	0363	0364	0365	0366	0367	60000	- 24578
0160	0112	0113	0114	0115	0116	0117	0118	0119	0580	0388	0369	0370	0371	0372	0373	0374	0375	70000	- 28672
0170	0120	0121	0122	0123	0124	0125	0128	0127	0570	0378	0377	0378	0379	0360	0381	0382	0383		
0200	0126	0129	0130	0131	0132	0133	0134	0135	0600	0384	0365	0386	0367	0368	0386	0390	0391		
0210	0136	0137	0138	0139	0140	0141	0142	0143	0610	0392	0393	0394	0395	0396	0397	0398 0406	0399 0407		
0220 0230	0144	0145 0153	0148 0154	0147 0155	0148 0158	0149 0157	0150 0158	0151 0159	0620 0630	0400 0408	0401 0409	0402 0410	0403 0411	0404 0412	0405 0413	0414	0415		
0240	0160	0181	0182	0183	0164	0165	0166	0167	0640	0418	0417	0418	0419	0420	0421	0422	0423		
0250	0166	0189	0170	0171	0172	0173	0174	0175	0850	0424	0425	0428	0427	0426	0429	0430	0431		
0280	0176	0177	0178	0179	0160	0161	0182	0163	0880	0432	0433	0434 0442	0435 0443	0436 0444	0437 0445	0438 0446	0439 0447	1	
0270	0164	0185	0186	0187	0188	0189	0190	0191	0670	0440	0441								
0300 0310	0192	0193 0201	0194 0202	0195 0203	0198 0204	0197 0205	0198 0206	0199 0207	0700	0448 0456	0449 0457	0450 0456	0451 0459	0452 0460	0453 0481	0454 0462	0455 0463		
0320	0206	0209	0210	0211	0212	0213	0214	0215	0720	0464	0485	0466	0487	0466	0469	0470	0471	1	
0330	0218	0217	0216	0219	0220	0221	0222	0223	0730	0472	0473	0474	0475	0478	0477	0476	0479	!	
0340 0350	0224 0232	0225 0233	0226 0234	0227 0 <b>23</b> 5	0226 0238	0229	0230	0231 0239	0740	0460 0488	0481 0489	0482	0483 0491	0484 0492	0485 0493	0488 0494	0487 0495	1	
History)		11/3/3	U/34	UZ35	U238	0237	0236	U238	: U/3U	U400								1	
							0246		0780	0496	0497	0496	0499	0500	0501	0502	0503	1	
0360 0370	0240 0248	0241 0249	0242 0250	0243 0251	0244 025 <b>2</b>	0245 0253	0246 0254	0247 0255		0496 0504	0505	0508	0507	0506	0509	0510	0511	]	
0360 0370	0240 0248	0241 0249	0242 0250 2	0243 0251 3	0244 0252 4	0245 0253 5	0254	0247 0255 7	0780 0770	0498 0504 O	0505	0508	3	0506 4	0509 5	0510 6	0511 7	1000	0517
0360	0240 0248	0241 0249	0242 0250	0243 0251 3 0515 0523	0244 0252 4 0516 0524	0245 0253 5 0517 0525	0254 6 0516 0528	0247 0255 <b>7</b> 0519 0527	0780 0770 1400 1410	0498 0504 0 0 0766 0776	0505 1 0769 0777	0508 2 0770 0778	3 0771 0779	4 0772 0780	0509 <b>5</b> 0773 0781	6 0774 0782	7 0775 0783	1000	0512 to
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TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 2 OF 4)

		0	1	2	3	4	5	6	7			0	1	2	3	4	5	6	7
2000 1024	2000	1G24	1025	1026	1027	1028	1029	1030	1031		2400	1260	1281	1282	1283	1284	1285	1286	1287
to to	2010	1032	1033	1034	1035	1036	1037	1038	1039		2410	1288	1289	1290	1291	1292	1293	1294	1295
2777 1535	2020	1040	1041	1042	1043	1044	1045	1046	1047		2420	1296	1297	1298	1299	1300	1301	1302	1303
(Octal) (Oecimal)	2030	1048	1049	1050	1051	1052	1053	1054	1055		2430	1304	1305	1306	1307	1308	1309	1310	1311 1319
	2040	1056	1057	1058	1059	1060	1061	1062	1063		2440	1312	1313	1314	1315	1316 1324	1317 1325	1318 1326	1327
	2050	1064	1065	1066	1067	1068 1076	1069 1077	1070 1078	1071 1079		2450 2460	1320 1326	1321 1329	1322 1330	1323 1331	1332	1333	1334	1335
Octal Occimal	2060	1072 1080	1073 1081	1074 1082	1075 1063	1084	1085	1086	1087		2470	1336	1337	1338	1339	1340	1341	1342	1343
10000 - 4096	2070	1000	1001	1002	1003	1004	1000	1000	1007		2470	1000	1557	1000	1000	10.10			
20000 - 8192	2100	1088	1089	1090	1091	1092	1093	1094	1095		2500	1344	1345	1346	1347	1348	1349	1350	1351
30000 - 12286	2100	1096	1097	1098	1099	1100	1101	1102	1103		2510	1352	1353	1354	1355	1356	1357	1358	1359
40000 - 16384	2120	1104	1105	1106	1107	1108	1109	1110	1111	- 1	2520	1360	1361	1362	1363	1364	1365	1366	1367
50000 - 20480	2130	1112	1113	1114	1115	1116	1117	1118	1119		2530	1366	1369	1370	1371	1372	1373	1374	1375
60000 - 24576	2140	1120	1121	1122	1123	1124	1125	1126	1127	l	2540	1376	1377	1378	1379	1380	1381	1382	1383
70000 - 28672	2150	1128	1129	1130	1131	1132	1133	1134	1135		2550	1364	1385	1386	1387	1388	1389	1390	1391
	2160	1136	1137	1138	1139	1140	1141	1142	1143		2560	1392	1393	1394	1395	1396	1397	1398	1399 1407
	2170	1144	1145	1146	1147	1148	1149	1150	1151		2570	1400	1401	1402	1403	1404	1405	1406	1407
	2200	1152	1153	1154	1155	1156	1157	1158	1159		2600	1408	1409	1410	1411	1412	1413	1414	1415
	2210	1160	1161	1162	1163	1164	1165	1166	1167		2610	1416	1417	1416	1419	1420	1421	1422	1423
	2220	1168	1169	1170	1171	1172	1173	1174	1175		2620	1424	1425	1426	1427	1428	1429	1430	1431
	2230	1176	1177	1176	1179	1160	1181	1182	1183		2630	1432	1433	1434	1435	1436	1437	1438	1439
	2240	1184	1185	1186	1187	1188	1189	1190	1191		2640	1440	1441	1442	1443	1444	1445	1446	1447
	2250	1192	1193	1194	1195	1196	1197	1198	1199	l	2650	1448	1449	1450	1451	1452	1453	1454	1455
	2260	1200	1201	1202	1203	1204	1205	1206	1207		2660	1456	1457	1458	1459	1460	1461	1462	1463
	2270	1208	1209	1210	1211	1212	1213	1214	1215		2670	1464	1465	1468	1467	1458	1469	1470	1471
	2300	1216	1217	1218	1219	1220	1221	1222	1223		2700	1472	1473	1474	1475	1476	1477	1478	1479
	2300	1224	1217	1218	1219	1228	1229	1230	1223		2710	1480	1481	1482	1483	1484	1485	1486	1487
	2320	1232	1233	1234	1235	1236	1237	1238	1239	1	2720	1488	1489	1490	1491	1492	1493	1494	1495
	2330	1240	1241	1242	1243	1244	1245	1246	1247		2730	1496	1497	1498	1499	1500	1501	1502	1503
	2340	1248	1249	1250	1251	1252	1253	1254	1255		2740	1504	1505	1506	1507	1506	1519	1510	1511
	2350	1256	1257	1258	1259	1260	1261	1262	1263	1	2750	1512	1513	1514	1515	1516	1517	1518	1519
	2360	1284	1265	1288	1287	1268	1269	1270	1271		2760	1520	1521	1522	1523	1524	1525	1526	1527
	2370	1272	1273	1274	1275	1276	1277	1278	1279		2770	1526	1529	1530	1531	1532	1533	1534	1535
		<u> </u>												_					7
0000 1500		0	1	2	3	4	5	6	7			0	1	2	3	4	5	6	7
3000 1538	3000	1536	1537	1538	1539	1540	1541	1542	1543		3400	1792	1793	1794	1795	1796	1797	1798	1799
to to	3010	1536 1544	1537 1545	1538 1546	1539 1547	1540 1548	1541 1549	1542 1550	1543 1551		3410	1792 1800	1793 1601	1794 1802	1795 1803	1796 1804	1797 1805	1798 1606	1799 1807
to to 3777 2047	3010 3020	1536 1544 1552	1537 1545 1553	1538 1546 1554	1539 1547 1555	1540 1548 1556	1541 1549 1557	1542 1550 1558	1543 1551 1559		3410 3420	1792 1800 1806	1793 1601 1809	1794 1802 1810	1795 1803 1811	1796 1804 1812	1797 1805 1813	1798 1606 1614	1799 1807 1815
to to	3010 3029 3030	1536 1544 1552 1560	1537 1545 1553 1561	1538 1546 1554 1562	1539 1547 1555 1563	1540 1548 1556 1564	1541 1549 1557 1565	1542 1550 1558 1568	1543 1551 1559 1567		3410 3420 3430	1792 1800 1806 1816	1793 1601 1809 1817	1794 1802 1810 1616	1795 1803 1811 1619	1796 1804 1812 1820	1797 1805 1813 1821	1798 1606 1614 1622	1799 1807 1815 1823
to to 3777 2047	3010 3029 3030 3040	1536 1544 1552 1560 1568	1537 1545 1553 1561 1569	1538 1546 1554 1562 1570	1539 1547 1555 1563 1571	1540 1548 1556 1564 1572	1541 1549 1557 1565 1573	1542 1550 1558 1566 1574	1543 1551 1559 1567 1575		3410 3420 3430 3440	1792 1800 1806 1816 1824	1793 1601 1809 1817 1825	1794 1802 1810 1616 1826	1795 1803 1811 1619 1827	1796 1804 1812 1820 1828	1797 1805 1813 1821 1829	1798 1606 1614	1799 1807 1815
to to 3777 2047	3010 3029 3030 3040 3050	1536 1544 1552 1560 1568 1578	1537 1545 1553 1561 1569 1577	1538 1546 1554 1562 1570 1576	1539 1547 1555 1563 1571 1579	1540 1548 1556 1564 1572 1580	1541 1549 1557 1565 1573 1581	1542 1550 1558 1568 1574 1582	1543 1551 1559 1567 1575 1583		3410 3420 3430	1792 1800 1806 1816	1793 1601 1809 1817	1794 1802 1810 1616	1795 1803 1811 1619	1796 1804 1812 1820	1797 1805 1813 1821	1798 1606 1614 1622 1830	1799 1807 1815 1823 1831
to to 3777 2047	3010 3020 3030 3040 3050 3060	1536 1544 1552 1560 1568 1576 1584	1537 1545 1553 1561 1569	1538 1546 1554 1562 1570	1539 1547 1555 1563 1571	1540 1548 1556 1564 1572	1541 1549 1557 1565 1573	1542 1550 1558 1566 1574	1543 1551 1559 1567 1575		3410 3420 3430 3440 3450	1792 1800 1806 1816 1824 1832	1793 1601 1809 1817 1825 1833	1794 1802 1810 1616 1826 1834	1795 1803 1811 1619 1827 1835	1796 1804 1812 1820 1828 1836	1797 1805 1813 1821 1829 1837	1798 1606 1614 1622 1830 1638	1799 1807 1815 1823 1831 1839
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TABLE 1A-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 3 OF 4)

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5000 5010 5020 5030 5040 5050 5060 5070	2560 2568 2576 2584 2592 2600 2608 2616	2581 2569 2577 2585 2593 2601 2609 2617	2562 2570 2578 2586 2594 2602 2610 2618	2563 2571 2579 2587 2595 2603 2611 2619	2564 2572 2580 2588 2596 2604 2612 2620	2565 2573 2581 2589 2597 2605 2613 2621	2566 2574 2582 2590 2598 2606 2614 2622	2567 2575 2583 2591 2599 2607 2615 2623	540 541 542 543 544 545 546	0 2874 0 2832 0 2840 0 2848 0 2856 0 2864	2817 2825 2833 2841 2849 2857 2865 2873	2818 2826 2834 2842 2850 2858 2866 2874	2819 2827 2835 2843 2851 2859 2867 2875	2820 2828 2836 2844 2852 2860 2868 2876	2821 2829 2837 2845 2853 2861 2869 2877	2822 2830 2838 2846 2854 2862 2870 2878	2823 2831 2839 2847 2855 2863 2871 2879	5000 to 5777 (Octal)	2580 to 3071 (Occum
5100 5110 5120 5130 5140 5150 5160 5170	2624 2632 2640 2648 2656 2664 2672 2680	2625 2633 2641 2649 2657 2665 2673 2681	2626 2634 2842 2650 2658 2666 2674 2682	2627 2635 2643 2651 2659 2667 2675 2683	2628 2636 2644 2652 2660 2668 2676 2684	2629 2637 2645 2653 2681 2669 2677 2685	2630 2638 2646 2654 2662 2670 2678 2686	2631 2639 2647 2655 2663 2671 2679 2687	550 551 552 553 554 555 556 557	2888 0 2896 0 2904 0 2912 0 2920 0 2928	2881 2889 2897 2905 2913 2921 2929 2937	2882 2890 2898 2906 2914 2922 2930 2938	2883 2891 2899 2907 2915 2923 2931 2939	2884 2892 2900 2908 2916 2924 2932 2940	2885 2893 2901 2909 2917 2925 2933 2941	2886 2894 2902 2910 2918 2926 2934 2942	2887 2895 2903 2911 2919 2927 2935 2943		
5200 5210 5220 5230 5240 5250 5260	2688 2896 2704 2712 2720 2728 2736 2744	2689 2697 2705 2713 2721 2729 2737 2745	2690 2698 2706 2714 2722 2730 2738 2746	2691 2699 2707 2715 2723 2731 2739 2747	2692 2700 2708 2716 2724 2732 2740 2748	2693 2701 2709 2717 2725 2733 2741 2749	2694 2702 2710 2718 2728 2734 2742 2750	2695 2703 2711 2719 2727 2735 2743 2751	560 561 562 583 564 565 566 567	2952 2960 2968 2978 2978 2984 2992	2945 2953 2961 2969 2977 2985 2993 3001	2946 2954 2962 2970 2978 2986 2994 3002	2947 2955 2963 2971 2979 2987 2995 3003	2948 2956 2964 2972 2980 2988 2996 3004		2950 2958 2966 2974 2982 2990 2998 3006	2951 2959 2967 2975 2983 2991 2999 3007		
5270	2752	27 <b>5</b> 3 2761 2769	2754 2782 2770	2755 2763 2771	2756 2764 2772 2780	2757 2765 2773 2781	2758 2786 2774 2782	2759 2787 2775 2763	570 571 572 573	3018	3009 3017 3025 3033	3010 3018 3026 3034	3011 3019 3027 3035	3012 3020 3028 3036	3021 3029	3014 3022 3030 3038	3015 3023 3031 3039		

TABLE 14-2. OCTAL-DECIMAL CONVERSION TABLE (SHEET 4 OF 4)

		F	0	1	2	3	4 !	5 6	3 7	, ]		Γ	0	1	2	3	4	5	6	7
			-								Γ	400	DD00	0000	0000	2221	3332	3333	3334	3335
6000	3072	6000	3072				3076 3084		307 <b>6</b> 3086	3079			3328 3336	3329 3337		3331 3339		3341	3342	3343
to	to	6010 6020	3080 3088		3090		3092		3094	3095		420	3344	3345		3347	3348	3349	3350	3351
6777	35 <b>8</b> 3	6030	3096		3098		3100		3102	3103	6	430	3352	3353		3355	3356	3357	3358	3359
(Octal)	(Oecimal)	6840	3104		3106	3107	3108	3109	3110	3111			3360	3361		3363		3365	3366	3367
		6050	3112	311 <b>3</b>	3114	3115	3116		3118	3119		3450	3368	3369		3371 3379	3372 33 <b>80</b>	3373 3381	3374 3382	3375 3383
		6060	3120	3121	3122		3124	3125 3133	3126 3134	3127		460 470	3376 3384	3377 3385		3387	3388	3389	3390	3391
	Decimal	6070	3128	3129	3130	3131	3132	3133	3134	3133	- 1	,,,,,	5001	0000						
10000 - 20000 -		6190	3136	3137	3138	3139	3140	3141	3142	3143		500	3 <b>392</b>	3393	3394	3395	3396	3397	3398	3399
30000 -		8110	3144	3145	3146	3147	3148	3149	3150	3151		3510	3400	3401	3402	3403 3411	3484 3412	3405 3413	3406 3414	3407 3415
48000 -		6120,	3152	3153	3154	3155	3156	3157 3165	3158 3166	3159		8520   85 <b>3</b> 0	3408 3418	3409 3417		3419	3420	3421	3422	3423
50000 -		6130 6140	3160 3168	3161 3169	3162 3170	3183 3171	3164 3172	3173	3174	3175		6540	3424	3425	3426	3427	3428	3429	3430	3431
60000 -		6150	3176	3177	3178	3179	3180	3181	3182	3183		8550	3432	3433	3434	3435	3436	3 <b>43</b> 7	3438	3439
70000 -		6160	3184	3185	3186	3 187	3188	3189	3190	3191		6560	3440	3441	3442	3443	3444	3445	3446	3447 3455
		6170	3192	<b>3</b> 193	3194	3195	3196	3197	3198	3199	- 1	6570	3448	3449	3450	3451	3452	3453	3454	3433
		6200	3200	3201	3202	3203	3204	3205	3206	3207	- 1	6600	3456	3457	3458	3459	3460	3461	3482	3463
		6210	3208	3209	3210	3211	3212	3213	3214	3215		6610	3464	3465	3466	3467	3468	3469	3470	3471
		6220	3216	3217	3218	3219	3220	3221	3222	3223		6620	3472 3480	3473 3481	3474 3482	3475 3483	3476 3484	3477 3485	3478 3486	3479 3487
		6230	3224	3225	3226	3227	3228 3236	3229 3237	3230 3238	3231 3239		6630 6 <b>64</b> 0	3480	3481	3482 3490	3483	3484 3492	3493	3494	3495
		6240 6250	3232 3240	32 <b>3</b> 3 3241	3234 3242	3235 3243	3230 3244	3245	3246	3247		6650	3496	3497	3498	3499	3500	3501	3502	3503
		6260	3248	3249	3250	3251	3252	3253	3254	3255	1	6660	3504	3505	3506	3507	3508	3509	3510	3511
		6270	3256	3257	3258	3259	3260	3261	3262	3263		6670	3512	3513	3514	3515	3516	3517	3518	3519
		6300	3264	3265	3266	3267	3268	3269	3270	3271		6700	3520	3521	3522	3523	3524	3525	3526	3527
		6310	3272	3273	3274	3275	3276	3277	3278	3279		67 10	3528	3529	3530	3531	3532	3533	3534	3535
		6320	3280	3281	3282	3283	3284	3285	3286	3287		6720	3536	3537	3538	3539	3540	3541	3542	3543
		6330	3288	3289	3290	3291	3292	3293	3294	3295		6730 6740	3544 3552	3545 3553	3546 3554	3547 3555	3548 3556	3549 3557	3550 3558	3551 3559
		6340	3296	3297	3 298 3 308	3299 3307	3300 3308	3301 3309	3302 3310	3303 3311		6750	3560	3561	3562	3563	3564	3565	3566	3567
		6350 6360	3304 3312	3305 331 <b>3</b>	3314	3315	3316	3317	3318	3319		6760	3568	3589	3570	3571	3572	3573	3574	3575
		6370	3320	3321	3322	3323	3324	3325	3326	3327		6770	3576	3577	3578	3579	3580	3581	3582	3583
			0	1	2	3	4	5	6	7			0	1	2	3	4	5	6	7
			<del>                                     </del>							0501	Γ	7400	3840	3841	3842	3843	3844	3845	3848	3847
7000	3584	7000	3584	3585	3586 3594	3587 3595	3588 3498	3589 3497	3590 3598	3591 3599		7400 7410	3848	3849	3850	3851	3852	3853	3854	3855
to	10	7010 7020	3592 3800	3593 3601	3602	3803	3804	3605	3806	3807		7420	3856	3857	3858	3859	3860	3861	3862	3863
7777	4095	7030	3608	3609	3610	3611	3612	3613	3814	3615		7430	3884	3865	3868	3867	3888	3869	3870	3871
(Octal)	(Oscimal)	7040	3616	3617	3618	3819	3620	3621	3622	3623		7440	3872	3873	3874	3875 3883	3876 3884	3877 3885	3878 3888	3879 3887
		7050	3624	3825	3626	3627	3628	3629	3630	3631 3639		7450 7460	3880 3888	3881 3889	3882 3890	3891	3892	3893	3894	3895
		7060	3632 3640	36 <b>3</b> 3 3641	3634 3642	3635 3843	3636 3644	3637 3845	3638 3 <b>64</b> 6	3647		7470	3896	3897	3898	3899	3900	3901	3902	3903
			1									7500	2004	2000	3906	3907	3908	3909	3910	3911
			3848	3649	3650	3651	3652	3653 3681	3654 3882	3655 3883		7500 7510	3904	3905 3913	3914	3915	3916	3917	3918	3919
		7100			3858	3859	3860 3868	3889	3870			7520	3920	<b>3</b> 921	3922	3923	3924	3925	3828	3927
		7110	3858	3657 3685						387	, ,				3930	3931	3932	3933	3834	3935
		7110 7120	3858 3864	3685 3873	3868 3674	3667 3875	3876	3877	3678	3871 3678		7530	3926	3929				00.00	00.40	
		7110 7120 7130 7140	3858 3664 3872 3680	3685 3873 3681	3868 3674 3682	3875 3883	3876 3684	3877 3685	367 8 388 8	3678 3887		7530 7540	3936	3937	3938	3939	3940 3948	3941	3942 3950	3943 3951
		7110 7120 7130 7140 7150	3858 3864 3872 3680 3888	3685 3873 3681 3889	3868 3674 3682 3890	3875 3883 3691	3876 3684 3692	3877 3685 3693	367 8 388 8 369 4	3678 3887 3695		7530 7540 7550	3936 3944	3937 3945	3938 3946	3939 3 <b>94</b> 7	3948	3949	3950	3951
		7110 7120 7130 7140 7150 7180	3858 3664 3872 3680 3888 3896	3685 3873 3881 3889 3697	3868 3674 3682	3875 3883	3876 3684	3877 3685	367 8 388 8	3678 3887		7530 7540	3936	3937	3938	3939				
		7110 7120 7130 7140 7150 7180 7170	3858 3864 3872 3680 3888 3696 3704	3685 3873 3681 3889 3697 3705	3868 3874 3682 3890 3698 3708	3875 3883 3691 3699 3707	3876 3684 3692 3700 3708	3877 3685 3693 3701 3709	3678 3888 3694 3702 3710	3678 3887 3695 3703 3711		7530 7540 7550 7560 7570	3936 3944 3952 3980	3937 3945 3953 3981	3938 3946 3954 3962	3939 3947 3955 3963	3948 3958 3984	3949 3957 3965	3950 3958 3966	3951 3959
		7110 7120 7130 7140 7150 7180 7170	3858 3664 3872 3680 3888 3696 3704	3685 3873 3681 3889 3697 3705	3868 3874 3682 3890 3698 3708	3875 3883 3691 3699 3707	3876 3684 3692 3700 3708	3877 3685 3693 3701 3709	3678 3888 3694 3702 3710	3678 3887 3695 3703 3711		7530 7540 7550 7560	3936 3944 3952	3937 3945 3953	3938 3946 3954	3939 3947 3955	3948 3958	3949 3957 3965 3973 3981	3950 3958 3966 3974 3982	3951 3959 3987 3975 3983
		7110 7120 7130 7140 7150 7180 7170 7280 7210	3858 3664 3872 3680 3888 3696 3704 3712 3720	3685 3873 3881 3889 3697 3705 3713 3721	3868 3874 3682 3890 3698 3708 3714 3722	3875 3883 3691 3699 3707	3876 3684 3692 3700 3708	3877 3685 3693 3701 3709 3717 3725	3678 3888 3694 3702 3710	3678 3887 3695 3703 3711		7530 7540 7550 7560 7570 7600	3936 3944 3952 3980 3968 3978 3864	3937 3945 3953 3981 3989 3977 3985	3938 3946 3954 3962 3970 3978 3986	3939 3947 3955 3963 3971 3979 3987	3948 3958 3984 3972 3980 3988	3949 3957 3965 3973 3981 3888	3950 3958 3966 3974 3982 3980	3951 3959 3987 3975 3983 3981
		7110 7120 7130 7140 7150 7180 7170	3858 3664 3872 3880 3888 3696 3704 3712 3720 3728	3685 3873 3681 3889 3697 3705	3868 3874 3682 3890 3698 3708	3875 3883 3691 3699 3707 3715 3723	3876 3684 3692 3700 3708 3716 3724	3877 3685 3693 3701 3709 3717 3725 3733 3741	3678 3888 3694 3702 3710 3718 3728 3734 3742	3678 3887 3695 3703 3711 3719 3727 3735 3743		7530 7540 7550 7560 7570 7600 7610 7820 7630	3936 3944 3952 3980 3968 3978 3864 3992	3937 3945 3953 3981 3989 3977 3985 3993	3938 3946 3954 3962 3970 3978 3986 3994	3939 3947 3955 3963 3971 3979 3987 3987	3948 3958 3984 3972 3980 3988 3898	3949 3957 3965 3973 3981 3888 3887	3950 3958 3966 3974 3982 3980 3988	3951 3959 3987 3975 3983 3981 3889
		7110 7120 7130 7140 7150 7188 7170 7280 7210 7220 7230 7240	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744	3685 3873 3581 3889 3697 3705 3713 3721 3729 3737 3745	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747	3876 3684 3692 3700 3708 3716 3724 3732 3740 3748	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750	3878 3887 3695 3703 3711 3719 3727 3735 3743 3751		7530 7540 7550 7560 7570 7600 7610 7820 7630 7640	3936 3944 3952 3980 3968 3978 3864 3992 4000	3937 3945 3953 3981 3989 3977 3985 3993 4001	3938 3946 3954 3962 3970 3978 3986 3994 4002	3939 3947 3955 3963 3971 3979 3987 3995 4003	3948 3958 3984 3972 3980 3988 3898 4004	3949 3957 3965 3973 3981 3888 3887 4005	3950 3958 3966 3974 3982 3980 3988 4006	3951 3959 3987 3975 3983 3981 3889 4007
		7110 7120 7130 7140 7150 7180 7170 7290 7210 7220 7230 7240 7250	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744 3752	3685 3873 3681 3889 3697 3705 3713 3721 3729 3737 3745 3753	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755	3876 3684 3692 3700 3708 3716 3724 3732 3740 3748 3758	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750 3758	3678 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759		7530 7540 7550 7580 7570 7600 7610 7820 7630 7640 7850	3936 3944 3952 3980 3968 3978 3864 3992 4000 4008	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009	3938 3946 3954 3962 3970 3978 3986 3994 4002 4010	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011	3948 3958 3984 3972 3980 3988 3898 4004 4012	3949 3957 3965 3973 3981 3888 3887	3950 3958 3966 3974 3982 3980 3988	3951 3959 3987 3975 3983 3981 3889
		7110 7120 7130 7140 7150 7188 7170 7200 7210 7220 7230 7240 7250 7280	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744 3752 3760	3685 3873 3681 3889 3697 3705 3713 3721 3729 3737 3745 3753 3781	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783	3876 3684 3692 3700 3708 3716 3724 3732 3740 3748 3758	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750	3878 3887 3695 3703 3711 3719 3727 3735 3743 3751		7530 7540 7550 7560 7570 7600 7610 7820 7630 7640	3936 3944 3952 3980 3968 3978 3864 3992 4000 4008 4018	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017	3938 3946 3954 3962 3970 3978 3986 3994 4002	3939 3947 3955 3963 3971 3979 3987 3995 4003	3948 3958 3984 3972 3980 3988 3898 4004 4012	3949 3957 3965 3973 3981 3888 3887 4005 4013	3950 3958 3966 3974 3982 3980 3988 4008 4014	3951 3959 3987 3975 3983 3981 3889 4007 4015
		7110 7120 7130 7140 7150 7180 7170 7210 7220 7230 7240 7250 7280 7270	3858 3864 3872 3880 3888 3696 3704 3712 3720 3728 3738 3744 3752 3760 3768	3685 3873 3681 3889 3697 3705 3713 3721 3729 3737 3745 3753 3781 3789	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782 3770	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771	3876 3684 3692 3708 3708 3716 3724 3732 3740 3748 3758 3764	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750 3758 3768 3774	3878 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759 3787		7530 7540 7550 7560 7570 7600 7610 7820 7630 7840 7850 7860 7670	3936 3944 3952 3980 3968 3978 3864 3992 4000 4008 4018 4024	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025	3938 3946 3954 3962 3970 3978 3986 3994 4002 4010 4018 4028	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019	3948 3958 3984 3972 3980 3988 3898 4004 4012 4020	3949 3957 3965 3973 3981 3888 3887 4005 4013 4021	3950 3958 3966 3974 3982 3980 3988 4006 4014 4022	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031
		7110 7120 7130 7140 7150 7188 7170 7200 7210 7220 7230 7240 7250 7280	3858 3864 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744 3752 3768	3685 3873 3681 3889 3697 3705 3713 3721 3729 3737 3745 3753 3781 3789	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771	3878 3684 3692 3708 3708 3716 3724 3732 3740 3748 3758 3784 3772	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773 3781	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750 3758 3768 3774 3782 3790	3878 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759 3787 3775		7530 7540 7550 7580 7570 7600 7610 7820 7630 7840 7850 7850 7870 7700 7710	3936 3944 3952 3980 3968 3978 3864 3992 4000 4008 4018 4024 4032 4040	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025 4033 4041	3938 3946 3954 3962 3970 3978 3986 3994 4002 4010 4018 4028 4034 4042	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019 4027 4035 4043	3948 3958 3984 3972 3980 3988 3898 40012 4020 4028	3949 3957 3965 3973 3981 3888 3887 4005 4013 4028 4037 4045	3950 3958 3966 3974 3982 3980 3988 4008 4014 4022 4030 4038 4048	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031
		7110 7120 7130 7140 7150 7180 7179 7210 7220 7230 7240 7250 7280 7270	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744 3752 3760 3768	3685 3873 3581 3889 3697 3705 3713 3721 3729 3737 3745 3753 3789 3777 3785	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3770 3778 3788 3794	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771 3779 3787 3786	3878 3684 3692 3708 3708 3716 3724 3732 3740 3748 3758 3784 3772 3780 3788	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773 3781 3789 3187	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750 3758 3768 3774 3782 3790 3798	3878 3887 3695 3703 3711 3719 3727 3735 3743 3751 3787 3787 3788		7530 7540 7550 7560 7570 7600 7610 7820 7830 7840 7850 7860 7870 7770 7710 7720	3938 3944 3952 3980 3968 3978 3884 3992 4000 4008 4018 4024 4032 4040 4048	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025 4033 4041 4048	3938 3946 3954 3962 3970 3978 3986 3994 4002 4010 4018 4028 4034 4042 4050	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019 4027 4035 4043 4051	3948 3958 3984 3972 3980 3988 3898 4004 4012 4020 4028 4038 4044 4052	3949 3957 3965 3973 3981 3888 3887 4005 4013 4021 4028 4037 4045	3950 3958 3966 3974 3982 3980 3988 4006 4014 4022 4030 4038 4048 4048	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031 4038
		7110 7120 7130 7140 7150 7180 7170 7290 7210 7220 7230 7240 7250 7250 7270 7310 7320 7320 7320 7320 7320 7320 7320 732	3858 3664 3872 3680 3888 3896 3704 3712 3720 3728 3738 3744 3752 3760 3768 3778 3784 3784 3784 3784	3685 3873 3681 3889 3697 3705 3713 3721 3729 3737 3745 3753 3781 3789 3777 3785 3783 3783	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782 3770 3778 3788 3794 3802	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771 3779 3787 3786 3803	3876 3684 3692 3708 3716 3724 3732 3740 3748 3758 3764 3772 3780 3788 3796	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773 3781 3789 3187 3805	367 8 388 8 3694 3702 3710 3718 3728 3734 3742 3750 3758 3768 3774 3782 3790 3798 3806	3678 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759 3787 3788 3791 3788 3807		7530 7540 7550 7560 7570 7600 7610 7820 7830 7840 7850 7860 7700 7710 7720 7730	3938 3944 3952 3980 3968 3978 3864 3992 4000 4008 4018 4024 4032 4040 4048 4056	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025 4033 4041 4048 4057	3938 3946 3954 3952 3970 3978 3986 3994 4002 4018 4028 4034 4042 4050 4058	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019 4027 4035 4043 4051 4058	3948 3958 3984 3972 3980 3988 4004 4012 4020 4026 4038 4044 4052 4060	3949 3957 3965 3973 3981 3888 3887 4005 4013 4021 4028 4037 4045 4053 4061	3950 3958 3966 3974 3982 3980 3988 4008 4014 4022 4030 4038 4048 4048	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031 4038 4047 4055 4063
		7110 7120 7130 7140 7150 7188 7179 7210 7220 7230 7240 7250 7286 7277 7300 7310 7320 7330 7330 7330	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3738 3744 3752 3760 3768 3778 3784 3782 3800 3808	3685 3873 3681 3889 3697 3705 3713 3729 3737 3745 3753 3781 3789 3787 3783 3801 3808	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782 3770 3778 3788 3794 3802 3810	3875 3883 3691 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771 3779 3786 3803 3811	3876 3684 3692 3708 3716 3716 3724 3732 3740 3748 3758 3764 3772 3780 3780 3786 3796 3804	3877 3685 3693 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773 3781 3781 3787 3805 3813	3678 3888 3694 3702 3710 3718 3728 3734 3742 3750 3758 3768 3774 3782 3790 3798 3806 3814	3678 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759 3787 3775 3788 3807 3618		7530 7540 7550 7560 7570 7600 7610 7630 7640 7850 7860 7770 7770 7770 7730 7740	3936 3944 3952 3980 3968 3978 3864 3992 4000 4008 4018 4024 4032 4040 4048 4056 4064	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025 4033 4041 4048 4057 4085	3938 3946 3954 3962 3970 3978 3986 3994 4002 4010 4018 4028 4034 4042 4050	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019 4027 4035 4043 4051	3948 3958 3984 3972 3980 3988 4004 4012 4020 4028 4036 4044 4052 4060 4068	3949 3957 3965 3973 3981 3888 3887 4005 4013 4021 4028 4037 4045 4063 4061	3950 3958 3966 3974 3982 3980 3988 4008 4014 4022 4030 4038 4048 4048	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031 4038
		7110 7120 7130 7140 7150 7180 7170 7290 7210 7220 7230 7240 7250 7250 7270 7310 7320 7320 7320 7320 7320 7320 7320 732	3858 3664 3872 3680 3888 3696 3704 3712 3720 3728 3738 3744 3752 3760 3768 3778 3784 3782 3808 3808 3818	3685 3873 3681 3889 3697 3705 3713 3729 3737 3745 3753 3781 3789 3777 3785 3783 3801 3808	3868 3674 3682 3890 3698 3708 3714 3722 3730 3738 3746 3754 3782 3770 3778 3788 3794 3802 3810	3875 3883 3891 3699 3707 3715 3723 3731 3739 3747 3755 3783 3771 3779 3787 3786 3803 3811 3818	3876 3684 3692 3708 3716 3716 3724 3732 3740 3748 3758 3764 3772 3780 3788 3788 3796 3812 3812	3877 3685 3893 3701 3709 3717 3725 3733 3741 3749 3757 3765 3773 3781 3789 3805 3813	367 8 3888 3694 3702 3710 3718 3728 37342 3750 3758 3768 3774 3782 3790 3798 3804 3814	3678 3887 3695 3703 3711 3719 3727 3735 3743 3751 3759 3787 3788 3791 3788 3807		7530 7540 7550 7560 7570 7600 7610 7820 7830 7840 7850 7860 7700 7710 7720 7730	3936 3944 3952 3980 3968 3978 3884 3992 4000 4008 4018 4024 4032 4040 4040 4056 4064 4072	3937 3945 3953 3981 3989 3977 3985 3993 4001 4009 4017 4025 4033 4041 4044 4057 4085 4073	3938 3946 3954 3962 3978 3978 3986 3994 4002 4018 4028 4034 4042 4058 4058	3939 3947 3955 3963 3971 3979 3987 3995 4003 4011 4019 4027 4035 4043 4051 4058 4067	3948 3958 3984 3972 3988 3898 4004 4012 4020 4028 4038 4044 4052 4060 4068 4078 4078	3949 3957 3965 3973 3981 3888 3887 4005 4013 4028 4037 4045 4063 4061 4068	3950 3958 3966 3974 3982 3980 3988 4008 4014 4022 4030 4038 4048 4064 4078 4078	3951 3959 3987 3975 3983 3981 3889 4007 4015 4023 4031 4038 4047 4055 4063 4071

TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 1 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000	.000000	.100	125000	200	05000		
.001	.001953	101	.126953	.200	.250000	.300	.375000
.002	.003906	102		.201	.251953	301	.376953
.003	.005859	103	126906	.202	253906	.302	.376906
.004	007612		.130659	203	.255859	.303	380659
005	.007612	.104	.132812	.204	257812	.304	.362812
.006	.011716	105	134765	.205	259765	305	.364765
.007		.106	.136716	.206	.261716	.306	386716
	.013671	.107	138671	.207	.263671	.307	.368671
.010 .011	.015625	.110	.140625	.210	265625	.310	.390625
.011	.017576	.111	.142576	.211	.267578	311	392576
.012	.019531	112	.144531	.212	.269531	312	394531
.013	.021464	.113	146464	.213	.271484.	.313	396464
	.023437	.114	.146437	.214	.273437	.314	.396437
.015	.025390	.115	.150390	.215	275390	.315	400390
.016	.027343	.116	.152343	.216	.277343	.316	402343
.017	.029296	.117	.154296	.217	279296	317	404296
020	.031250	.120	.158250	.220	.261250	.320	
021	.033203	.121	.158203	221	283203		406250
.022	.035156	.122	.1 <b>6</b> 0156	222	285156	.321	.408203
.023	037109	.123	162109	.223	.287109	.322	410156
.024	039062	.124	164062	224	.289062	.323	.412109
.025	.041015	.125	166015	.225		.324	414062
.026	.042968	.126	167966	.226	.291015	.325	.416015
.027	.044921	.127	169921	.227	.292968 .294921	.326	.417966
.030	.046875	ł		1		.327	.419921
.031	.048626	.130	171675	.230	.296675	.330	.421675
032	.050761	.131	173626	.231	298826	331	423826
.033	.052734	.132	.175761	232	.300761	.332	.425761
.034	.054687	.133	.177734	233	.302734	.333	.427734
.035	.056640	.134	.179687	.234	.304687	.334	429667
.036	.058593	135	.181640	.235	.306640	.335	431640
		.136	163593	.236	.306593	336	433593
.037	.060546	.137	165546	.237	.310546	337	435546
.040	062500	.140	.187500	.240	.312500	.340	407.000
.041	.064453	.141	189453	241	314453		437600
.042	.066406	.142	191406	242	316406	.341	439453
.043	.068359	.143	193359	243	.318359		441406
.044	.070312	.144	.195312	244	320312	.343	443359
.045	.072285	.146	197265	245	.322265	344	.445312
.046	.074218	148	199218	246	.324216	.345	447285
.047	.078171	.147	.201171	.247	326171	346	.449218 .451171
.050	.078125	.150	.203125				
.051	080078	.151	.205076	.250	.328125	350	453125
.052	.082031	.162	207031	.251	330078	.351	455078
.053	083984	.153	208984	.252	.332031	.352	.457031
.054	.085937	.154	.210937	.253	333984	.353	458964
.055	067890	.155	.212890	254	<b>3</b> 35937	.354	460937
.056	089843	158	214843	.255	.337890	.355	462890
.057	.091796	.157	.214643	.256	339843	.356	.464843
.060	002750	ļ		.257	341796	.357	466796
.081	.093750 .095703	.160	.218750	260	343750	.360	488750
082	.097856	.161	.220703	.261	.345703	361	470703
083	.099609	.162	222656	262	.347668	.382	472658
.084		.163	224609	.263	.349609	.383	474609
.065	101562 103515	.164	226562	264	.351562	364	.476662
.086		165	228516	.265	353515	.365	478515
.067	105468	.186	230468	.266	.355488	.386	480468
	.107421	.167	232421	.267	.357421	367	482421
.070	109375	.170	234375	.270	.369375	.370	464375
,071	111328	.171	236328	.271	361328	.370	
.072	.113281	.172	238261	.272	363261	.371	486328
.073	.115234	.173	240234	.273	365234		.488281
.074	.117187	.174	242167	.274	.365234	.373	490234
.075	119140	.175	244140	275	.369140	.374	492167
.076	121093	176	246093	276	.371093	.375	494140
.077	123046	.177	246046	277	373046	376	496093
				211	.5/3040	.377	498046

TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 2 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
	0000==						
.000400	.000976	.000500	.0 <b>0</b> 1220	.000600	.001454	.000700	.001708
.000401	.000980	.000501	.001224	.000601	.001468	.000701	.001712
.000402	.000984	.000502	.001228	.000502	.001472	.000702	.001716
.000403	.000988	.000503	.001232	.000503	.001476	.000703	.001720
.000404	.000991	.000504			.001470	.000704	
	.000991		.001235	.000604			.001724
.000405		.000505	.001239	.000605	.001483	.000705	.001728
.000405	.000999	.000506	.001243	.000606	.001487	.000706	.001731
.000407	.001003	.000507	.001247	.000607	.001491	.000707	.001735
.000410	.001007	.000510	.001251	.000610	.001495	.000710	.001739
.000411	.001010	.000511	.001255	.000611	.001499	.000711	.001743
.000412	.001014	.000512	.001258	.000512	.001502	.000712	.001747
.000413	.00101 <b>8</b>	.000513	.001262	.000613	.001506	.000713	.001750
.000414	.001022	.000514	.001266	.000514	.001510	.000714	.001754
.000415	.001026	.000515	.001270	.000515	.001514	.000715	.001758
.000416	.001029	.000515	.001274	.000616	.001518	.000716	.001762
.000417	.001033	.000517	.001277	.000617	.001522	.000717	.001766
.000417	.001000	.000517	.001277	.000017	.001322	.000717	.001700
.000420	.001037	.000520	.001281	.000620	.001525	.000720	.001770
.000421	.001041	.000521	.001285	.000621	.001529	.000721	.001773
.000421	.001041	.000521	.001289	.000621	.001523	.000721	.001773
.000422	.001045		.001289				.001777
		.000523		.000623	.001537	.000723	
.000424	.001052	.000524	.001296	.000524	.001541	.000724	.001785
.000425	.001056	.000525	.001300	.000625	.001544	.000725	.001789
.000426	.001060	.000526	.001304	.000626	.001548	.000726	.001792
.000427	.001064	.000527	.001308	.000627	.001552	.000727	.001796
.000430	004000	000505	001010	000000	004550	000705	004600
	.001069	.000530	.001312	.000630	.001556	.000730	.001800
.000431	.001071	.000531	.001316	.000631	.001560	.000731	.001804
.000432	.001075	.000532	.001319	.000632	.001564	.000732	.00180 <b>8</b>
000433	.001079	.000533	.001323	.000633	.001567	.000733	.001811
.000434	.001 083	.000534	.001327	.000634	.001571	.000734	.001815
.000435	.001087	.000535	.001331	.000635	.001575	.000735	.001819
.000436	.001091	.000536	. <b>0</b> 01335	.000636	.001579	.000736	.001823
.000437	.001094	.000537	.001338	.000637	.001583	.000737	.001827
000440	001000	000540	001010				
.000440	.001096	.000540	.001342	.000640	.001586	.000740	.001631
.000441	.001102	.000541	.001346	.000641	.001590	.000741	.001834
.000442	.001106	.000542	.0013 <b>50</b>	.000642	.001594	.000742	.001838
.000443	.001110	.000543	.001354	.000643	.001598	.000743	.001842
.000444	.001113	.000544	.001358	.000644	.001602	.000744	.001646
.000445	.001117	.000545	.001361	.000545	.001605	.000745	.001650
.000446	.001121	.00054€	.001365	.000546	.001609	.000746	.001853
.000447	.001125	.000547	.001369	.000647	.001613	.000747	.001657
.000450	.001126	.000550	.001373	.000650	.001617	.000750	.001861
.000451	.001132	.000551	.001377	.000651	.001621	.000751	.001865
.000452	.001136	.000552	.001360	.000652	.001625	.000752	.001669
.000453	.001140	.000553	.001364	.000653	.001626	.000753	.001673
.000454	.001144	.000554	.001368	.000654	.001632	.000754	.001676
.000455	.001146	.000555	.001392	.000655	.001636	.000755	.001660
.000456	.001152	.00055€	.001396	.000656	.001640	.000756	.001684
.000457	.001155	.000557	.001366	.000657	.001644	.000757	.001686
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		.550007	,501000	.550007	.001077	.550,07	.55,566
.000460	.001159	.000560	.001403	.000660	.001647	.000760	.001692
.000461	.001163	.000561	.001407	.000661	.001651	.000761	.001665
.000462	.001167	.000562	.001411	.000662	.001655	.000762	.001896
.000463	.001171	.000563	.001415	.000663	.001656	.000763	.001903
.000464	.001174	.000564	.001419	.000664	.001663	.000764	001607
.000465	.001176	000565	.001422	.000665	.001667	.000765	.001911
000466	.001182	.000586	.001426	.000666	.001670	.000766	001914
.000467	.001166	.000567	.001428	.000667	.001674	.000767	.001618
		.000007	.501750	.550007		.5507.07	
.000470	.001190	.000570	.001434	.000670	.001678	.000770	.001622
.000471	.001164	.000571	.001438	.000671	.001682	.000771	.001626
.000472	.001197	.000572	.001441	.000672	.001666	.000772	.001930
.000473	.001201	.000573	.001445	.000673	.001669	.000773	.001934
.000474	001205	.000574	.001449	.000674	.001693	.000774	.001937
.000475	.001209	.000575	.001453	.000675	.001697	.000775	.001941
.000476	.001213	.000576	.001457	.000676	.001701	.000776	.001945
.000477	.001216	.000577	.001461	.000677	.001705	.000777	001949
	.501210	.000077	.501751	.550077	.501,50		.001849

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TABLE 1A-3. OCTAL-DECIMAL FRACTION CONVERSION TABLE (SHEET 3 OF 3)

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	COTA	Dr.
						OCTAL	DEC.
000000	000000	.000100	.000244	.000200	.000488	.000300	.000732
.000001	.000003	.000101	.000247	.000201	.000492	.000301	.000736
.000002	.000007	.000102	.000251	.000202	.000495	.000302	.000740
.000003	.000011	.000103	.000255	.000203	.000499	.000303	
.000004	.000015	.000104	.000259				.000743
.000005	.000019	.000105		.000204	000503	000304	.000747
			.000263	.000205	.000507	.000305	.000751
.000006	.000022	.000106	.000267	.000206	.000511	.000306	.000755
.000007	.000026	.000107	.000270	.000207	.000514	.000307	.000759
.000010	.000030	.000110	.000274	000010			
.000011	.000034			.000210	.000518	.000310	.000762
		.000111	000278	.000211	.000522	.000311	.000766
.000012	.000038	.000112	.000282	.000212	000526	.000312	.000770
.000013	.000041	.000113	.000286	.000213	.000530	.000313	.000774
.000014	000045	.000114	.000289	.000214	.000534	000314	.000778
.000015	.000049	.000115	.000293	.000215	000537		
.000016	000053					.000315	.000782
		.000116	000297	.000216	.000541	.000316	.000785
.000017	.000057	.000117	.000301	.000217	.000545	.000317	.000789
.000020	.000061	.000120	.000305	.000220	.000549	.000320	.000793
.000021	.000064	.000121	.000308	.000220	.000543	.000320	.000793
.000022	.000068	000121					
.000022	.000072		.000312	.000222	.000556	.000322	.000801
		.000123	.000316	.000223	.000560	.000323	.000805
.000024	.000076	.000124	.000320	.000224	.000564	.000324	.000808
.000025	.000080	.000125	.000324	.000225	.000568	.000325	.000812
.000026	.000083	.000126	.000328	.000226	.000572	.000326	.000816
.000027	.000087	.000127	.000331	.000227	.000576	.000327	000810
.000030	.000091	.000130	000335	00000			
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.000036	.000114	.000136	.000358	000236			
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		l	.000302	.000237	.000000	.000337	.000850
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.000042	.000129	.000142	.000373	.000242	.000817	000342	
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	.000141	000145	.000385	.000245	.000629	.000345	.000873
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.000071	.000217	.000170	.000461				
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<del>- · ·</del>		.000177	.500704	-000277	.000728	.000377	.000972

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